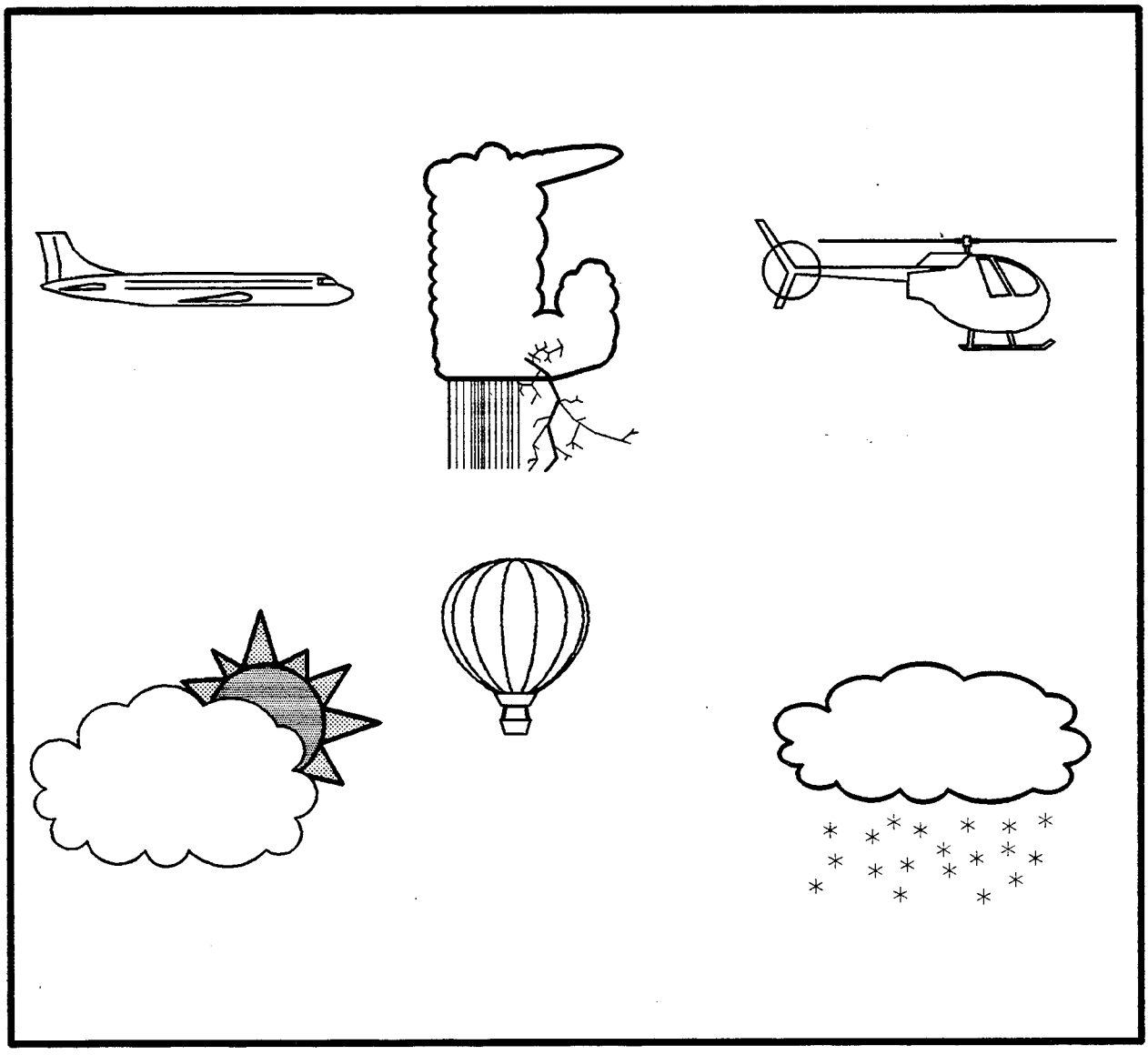
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

AVIATION WEATHER SERVICES

AC 00-45D



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PREFACE

AC 00-45D, Aviation Weather Services, is published jointly by the Federal Aviation Administration and the National Weather Service (NWS).

This document supplements the companion manual **AC 00-6A, Aviation Weather** that deals with weather theories and hazards.

Lee Harrison, National Weather Service Coordinator and Training Consultant at the FAA Academy, directed the preparation of AC 00-45D. Robert S. Hamilton, NWS Meteorology Instructor, and Lee Harrison, were the primary writers and organizers of the manual. Other NWS Meteorology Instructors who contributed material, comments, suggestions and quality control to the overall production of the manual include Bill Barlow, Kim Brabander, Dick Mitchem, Jon Osterberg, David Sandoval, and Stacy Stewart. The Aviation Services Branch of National Weather Service Headquarters, in particular, Dan Gudgel, contributed through review and suggested changes to the publication. Recognition is given to David Sandoval, who did the computer generated illustrations. A special thanks to Nadine Jewell for her help and interest in editing this manual.

Because of the rapid expansion of air transportation and increased aviation demands, it is necessary to move toward self briefings. As a result, pilots must become increasingly self-reliant in getting weather information.

This advisory circular, **AC 00-45D,** explains weather service in general and the details of interpreting and using coded weather reports, forecasts, and observed and prognostic weather charts. Many charts and tables apply directly to flight planning and in-flight decisions.

This advisory circular contains 15 sections of information needed by pilots. It can also be used as a source of study for pilot certification examinations.

Comments and suggestions for improving this publication are encouraged and should be directed to:

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Advisory Circular, **AC 00-45D,** supersedes **AC 00-45C,** Aviation Weather Services, revised 1985.

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Section 1

THE AVIATION WEATHER SERVICE PROGRAM

Providing weather service to aviation is a joint effort of the National Weather Service (NWS), the Federal Aviation Administration (FAA), the Department of Defense (DOD), and other aviation oriented groups and individuals. This section discusses the civilian agencies of the federal government and their services to the aviation community.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

The National Oceanic and Atmospheric Administration (NOAA) is an agency of the Department of Commerce. NOAA is one of the leading scientific agencies in the U.S. government. Among its six major divisions are the National Environmental Satellite Data and Information Service (NESDIS) and the NWS.

NATIONAL ENVIRONMENTAL SATELLITE DATA AND INFORMATION SERVICE (NESDIS)

The National Environmental Satellite Data and Information Service (NESDIS) is located Washington, D.C. NESDIS directs the weather satellite program. Some NESDIS personnel work in close cooperation with NWS meteorologists at the National Meteorological Center (NMC) Satellite Field Distribution Facility (SFDF). Figures 3-4 and 3-5 are examples of Geostationary Operational Environmental Satellite (GOES) images, and Figures 3-6 and 3-7 are examples of NOAA Polar Orbiting Satellite images received from a SFDF. Satellite cloud images are available at field offices via the Satellite Weather Information System (SWIS) or a "GOES Tap" phone line.

NATIONAL WEATHER SERVICE (NWS)

The National Weather Service collects and analyzes meteorological and hydrological data, and subsequently prepares forecasts on a national, hemispheric, and global scale. The following is a description of the NWS facilities tasked with these duties.

National Meteorological Center (NMC)

The National Meteorological Center (NMC), located in Washington D.C., is the focal point of the NWS's weather processing system. From worldwide weather reports, NMC prepares weather analysis charts and guidance forecasts for use by NWS offices and other users. A few charts and forecasts are still manually prepared by meteorologists, but the majority are computer generated.

Some NMC products are specifically prepared for aviation. For example, the Winds and Temperatures Aloft Forecast. Figure 1-3 is the network of forecast winds and temperatures aloft for the contiguous 48 states. Figure 1-3A shows the Alaskan and Hawaiian network.

National Severe Storms Forecast Center (NSSFC)

The National Severe Storms Forecast Center (NSSFC) prepares and issues convective outlooks and forecasts, in addition to severe weather watches, for the conterminous 48 states. NSSFC is located in Kansas City, MO, near the heart of the area most frequently affected by severe thunderstorms.

National Hurricane Center (NHC)

The National Hurricane Center (NHC), located in Miami, FL, issues Hurricane Advisories for the Atlantic, the Caribbean, the Gulf of Mexico, the eastern Pacific, and adjacent land areas. The center also develops hurricane forecasting techniques and does hurricane research. The Central Pacific Hurricane Center in Honolulu issues Advisories for the central Pacific Ocean.

National Aviation Weather Advisory Unit (NAWAU)

The National Aviation Weather Advisory Unit, located in Kansas City, MO, is dedicated to aviation. Meteorologists in this unit prepare and issue aviation Area Forecasts (FA) and In-Flight Weather Advisories [Airman's Meteorological Information (AIRMET), and Significant Meteorological Information (SIGMET) and Convective SIGMETs] for the contiguous 48 states (Figure 1-4)].

Weather Service Forecast Office (WSFO)

A Weather Service Forecast Office (WSFO) issues various public and aviation forecasts and weather warnings for their area of responsibility. In support of

aviation, the forecasts include Terminal Forecasts, as well as the forecasts used in the Transcribed Weather Broadcast (TWEB). The WSFOs in Alaska and Hawaii issue aviation Area Forecasts and In-Flight Advisories (AIRMETS, and international SIGMETS).

Figure 1-5 show locations for which Terminal Forecasts are issued. Figure 1-6 shows the TWEB routes.

Selected WSFOs also provide formal pilot weather briefings. Flight plan filing and NOTAM services are not available at NWS offices. Pilots can still receive specifically requested weather information from those WSFOs that do not offer formal briefings.

Weather Service Office (WSO)

A Weather Service Office (WSO) prepares and issues public forecasts and weather warnings and provides general weather service for their local areas. Some WSOs provide formal pilot weather briefings, but the majority of them do not. Pilots can still receive specifically requested weather information from those offices that do not offer formal briefings.

Weather Forecast Office (WFO)

The National Weather Service is currently undergoing a major Modernization and Associated Restructuring (MAR) in which the present field offices will be realigned into a new type of office. This office will be known as a Weather Forecast Office (WFO). These new offices will replace the present WSFO/WSO concept and will be designed to take advantage of WSR-88D Doppler Radar and other new technology to improve weather services. The WFOs will be staffed primarily with meteorologists and serve smaller areas than current WSFOs do. The second stage of the MAR is expected to be completed by the late 1990s.

FEDERAL AVIATION ADMINISTRATION (FAA)

The Federal Aviation Administration is a part of the Department of Transportation. The FAA provides a wide range of services to the aviation community. The following is a description of those FAA facilities which are involved with aviation weather and pilot services.

Flight Service Stations (FSS)

The FAA is in the process of modernizing its Flight Service Station program with two types of Flight Service Stations (FSSs). The first type is the older, manual (or non-automated) FSS which is the process of being consolidated into the second, newer, Automated FSS (AFSS). With about one per state and with lines of communications radiating out from it, these new AFSSs are referred to as "hub" facilities. Pilot services provided previously by the older FSSs have been consolidated into facilities with new technology to improve Pilot Weather Briefing services.

The FAA Flight Service Station (FSS or AFSS) provides more aviation weather briefing service than any other government service outlet. The FSS or AFSS provides preflight and inflight briefings, transcribed weather briefings, scheduled and unscheduled weather broadcasts, and furnishes weather support to flights in its area.

As a starting point for a preflight weather briefing, a pilot may wish to listen to one of the following three recorded weather briefings a FSS or AFSS can provide. For a more detailed briefing pilots can contact the FSS or AFSS directly.

Transcribed Weather Broadcast (TWEB)

The Transcribed Weather Broadcast (TWEB) is a continuous broadcast on selected low/medium frequency navigation facilities (190 to 535 kHz) and VORs (108.0 to 117.95 MHz). The TWEB is based on a route-of-flight concept with the order and content of the TWEB transcription as follows:

1. Introduction
2. Synopsis
3. Adverse Conditions
4. TWEB Route Forecasts
5. Outlook (Optional)
6. Winds Aloft
7. Radar Reports
8. Aviation Weather Observations
9. Pilot Reports (PIREP)
10. Notices to Airmen (NOTAMs)
11. Military Training Activity
12. Density Altitude
13. Closing Announcement

Items 2, 3, 4, 5, and 6 are Forecasts and Advisories prepared by the NWS and are discussed in detail in Section 4. The Synopsis and Route Forecasts are prepared specifically for the TWEB by WSFOs. Adverse conditions, outlooks, and winds/temperature aloft are adapted from In-Flight Advisories, Area Forecasts, and the NMC Winds/Temperature Aloft Forecasts. Radar reports and pilot reports are discussed in Section 3. Surface reports are discussed in Section 2.

Figure 1-6 shows TWEB routes for which forecasts are prepared.

Pilot's Automatic Telephone Weather Answering System (PATWAS)

Pilot's Automatic Telephone Weather Answering

System (PATWAS) is a recorded telephone briefing service done by some manual FSSs with the forecast for the local area, usually within a 50 nautical mile radius of the station. A few selected stations also include Route Forecasts similar to the TWEB.

The order and content of the PATWAS recording is as follows:

1. Introduction (describing PATWAS area)
2. Adverse Conditions
3. Recommendation (VFR flight not recommended, if appropriate)
4. Synopsis
5. Current Conditions
6. Surface Winds
7. Forecast
8. Winds Aloft
9. NOTAMs
10. Military Training Activity
11. Request for PIREPs
12. Alert Notices (ALNOT), if applicable
13. Closing Announcements
14. Suspension Announcement

FAA facilities providing PATWAS have operational procedures that place a high operational priority on PATWAS. This ensures the information is current and accurate. Detailed PATWAS information is usually prepared at selected time intervals between 0500 and 2200 local time with updates issued as needed. A general outlook for the PATWAS area is available between 2200 and 0500 local time if service is reduced during the period. The Airport Facility Directory lists PATWAS telephone numbers for FSS briefing offices.

Transcribed Information Briefing Service (TIBS)

Transcribed Information Briefing Service (TIBS) is provided by AFSSs and provides continuous telephone recordings of meteorological and/or aeronautical information. Specifically, TIBS provides area and/or route briefings, airspace procedures, and special announcements, if applicable, concerning aviation interests.

Depending on user demand, other items provided may include Aviation Weather Observations, Terminal Forecasts, and Winds/Temperatures Aloft Forecasts. A general outlook for the TIBS is available between 2200 and 0500 local time if service is reduced during the period. The Airport Facility Directory lists TIBS telephone numbers for AFSS briefing offices. A touch-tone telephone is necessary to access the TIBS program.

For those pilots already in flight and needing weather information and assistance, the following services are provided by flight service stations. They can be accessed over the proper radio frequencies printed, in flight information publications.

Hazardous Inflight Weather Advisory Service (HIWAS)

The Hazardous Inflight Weather Advisory Service (HIWAS) is a continuous broadcast service over selected VORs of In-Flight Weather Advisories; i.e. SIGMETs, CONVECTIVE SIGMETs, AIRMETs, Severe Weather Forecast Alerts (AWW), and Center Weather Advisories (CWA). [See Section 4 for a description of CWAs]. In areas where HIWAS is already being utilized, controllers and specialists have discontinued their routine broadcast of In-Flight Advisories, but continue to broadcast a short alerting message.

En Route Flight Advisory Service (EFAS)

The En Route Flight Advisory Service (EFAS), or "Flight Watch," is a weather service on a common frequency (122.0 mHz), and on discrete frequencies at flight levels above 18,000 feet, from selected FSSs or AFSSs. The Flight Watch specialist provides aviation weather information, time-critical assistance to en route pilots facing hazardous or unknown weather conditions, and may recommend alternate or diversionary routes. Additionally, Flight Watch is a focal point for rapid receipt and dissemination of pilot reports. Figure 1-7 indicates the sites where EFAS and associated outlets are located. To use this service, call "FLIGHT WATCH." Example, "(Oakland) FLIGHT WATCH, THIS IS ..."

The following paragraphs describe other FAA facilities which provide support to the aviation community.

Air Traffic Control System Command Center (ATCSCC)

The Air Traffic Control Command Center (ATCCC) is located in the Washington, D.C. area with the objective of managing the flow of air traffic on a system-wide basis. The purpose is to minimize air traffic delays by watching capacity and demand, thereby achieving maximum utilization of the airspace.

Because weather is the most common reason for air traffic delays and reroutings, the ATCCC is supported full-time by NWS meteorologists in the Central Flow Weather Service Unit (CFWSU) located in the Central Flow Control Facility (CFCF). These NWS meteorologists monitor the weather throughout the Air Traffic System and anticipate weather developments that might affect system operations on the national level.

Air Route Traffic Control Center (ARTCC)

An Air Route Traffic Control Center (ARTCC) is an en route radar facility established to provide air traffic control service to aircraft operating on IFR flight plans within controlled airspace and principally during the en route phase of flight. When equipment capabilities and controller workload permit, certain advisory/assistance services may be provided to VFR aircraft.

Center Weather Service Unit (CWSU)

The purpose of the Center Weather Service Units (CWSU) are to provide weather consultation and advice to managers and staff within ARTCCs and to other supported FAA facilities. The CWSU is a joint agency aviation weather support team located at each ARTCC. The unit is composed of NWS meteorologists and FAA traffic management personnel, the latter being assigned as Weather Coordinators. The CWSU meteorologist provides FAA traffic managers with accurate and timely weather information. This information is based on monitoring, analysis, and interpretation of real-time weather data at the ARTCC through the use of all available data sources including radar, satellite, PIREPs, and various NWS products such as Terminal and Area Forecasts, In-Flight Advisories, etc. The flow or exchange of weather information between the CWSU meteorologists and the FAA personnel in the ARTCC is the responsibility of the Weather Coordinator.

Similar to the CWSUs in the ARTCCs, there is a Central Flow Weather Service Unit (CFWSU) located in the Central Flow Control Facility (CFCF) in the ATCSCC. The on-duty meteorologist in the CFWSU has the responsibility of weather coordination on the national level.

Air Traffic Control Tower (ATCT)

The FAA Terminal Controller informs arriving and departing aircraft of pertinent local weather conditions. The controller becomes familiar with and remains aware of current weather information needed to perform air traffic control duties in the vicinity of the terminal. The responsibility for reporting visibility observations is shared with the NWS at many ATCT facilities. At other tower facilities, the controller has the full responsibility for observing, reporting and classifying aviation weather elements.

Automatic Terminal Information Service (ATIS) is provided at most major airports to inform pilots, as they approach the terminal area, of the current weather and other pertinent local airport information.

Direct User Access Terminal Service (DUATS)

Direct User Access Terminal System (DUATS) is an FAA operated information system which enables pilots and other aviation interests to conduct their own weather briefings. The computer-based system receives and stores a number of NWS and FAA products which are commonly used in pilot weather briefings. Pilots using a personal computer and modem can access the system and request weather and other pertinent data for planned flights. The pilot can also file and amend flight plans while dialed into the system. Further information about DUATS can be obtained from any AFSS or FAA Flight Standards District Office (FSDO).

AM WEATHER

AM WEATHER is a fifteen-minute weather program aired Monday through Friday mornings over more than 300 Public Broadcast Television Stations.

Professional meteorologists from the NWS and NESDIS provide weather information primarily for pilots enabling them to make better "go or no-go" flight decisions.

National and Regional Weather Maps along with satellite sequences, Radar Reports, Winds/Temperature Aloft Forecasts, AWWs, and In-Flight Weather Advisories. Extended Forecasts are provided Monday through Friday. Friday's forecast covers the weekend. AM WEATHER also serves many other interest groups that depend upon weather information.

AM WEATHER utilizes the U.S. weather observation network, GOES and NOAA Polar Orbiting satellite data, and computer analysis to produce daily aviation outlooks.

For Alaskan aviation weather interests, a meteorologist from WSFO Anchorage conducts a 30-minute program, Monday through Friday, on Alaska's Public Television. This broadcast airs at 6 PM local time throughout the state.

OBSERVATIONS

Weather observations are measurements and estimates of existing weather conditions both at the surface and aloft. When recorded and transmitted, an observation becomes a report and reports are the basis of all weather analyses, forecasts, advisories, and briefings. The following paragraphs briefly describe the observation programs of the NWS and the FAA. More detailed information on each program can be found in the following sections.

Surface Aviation Weather Observations

Surface Aviation Weather Observations include weather elements pertinent to flying. A network of airport stations provides routine up-to-date surface weather information. Most of the stations in the network are either NWS or FAA; however, the military services and contracted civilians are also included. Automated Surface Observing Systems (ASOS), Automated Weather Observing System (AWOS), and other automated weather observing systems are becoming a major part of the surface weather observing network. For more information on surface aviation observations, see Section 2.

Upper Air Observations

Upper air weather data is received from sounding balloons (known as radiosonde observations) and PIREPs. Upper air observations are taken twice daily at specified stations. These upper air observations furnish temperature, humidity, pressure, and wind data, often to heights above 100,000 feet. In addition, pilots are a vital source of upper air weather observations. In fact, aircraft in flight are the only means of directly observing turbulence, icing, and height of cloud tops. For more information on PIREPS, see Section 3.

A new sensing system utilizing vertically oriented radars will provide increased real-time data from the upper atmosphere. These radars will provide wind profiles of the atmosphere; hence, the system is known as the Profiler Network. At present, upper-level winds are the only data obtained from the network, but in time other parameters such as temperature and moisture content at various levels may be available. A limited network of profilers is being tested in the central part of the country. Nationwide deployment is expected in the near future.

Radar Observations

Precipitation reflects radar signals and the reflected signals are displayed as echoes on the radar scope. NWS radar covers all the United States east of the Rocky Mountains with radar coverage over the remainder of the U.S. largely by ARTCC radars. Except for some western mountainous terrain, radar coverage is nearly complete over the contiguous 48 states. Figure 1-1 shows the radar observation network.

A Radar Remote Weather Display System (RRWDS) is specifically designed system to provide *real-time* radar weather information from many different radars. The RRWDS display is similar to the color video display systems. RRWDS is connected to FAA and Air Force Air Route Surveillance radars as well as NWS weather radars. The system gives briefers access to real-time radar weather information across the entire country.

A new radar system, the WSR-88D, is being installed across the United States and is a joint effort of the NWS, FAA and DOD. These radars use Doppler technology which provides greater detail and enhanced information about thunderstorms and weather systems in support of public and aviation warning and forecast programs. Figure 1-2 shows the proposed WSR-88D observing network. As the Doppler radars are commissioned, the older conventional weather radars will be decommissioned.

An FAA Doppler radar, Terminal Doppler Weather Radar (TDWR), is being installed near a number of major airports around the country. The TDWR will be specifically used to alert and warn airport controllers of approaching wind shear, gust fronts, and heavy precipitation which could cause hazardous conditions for landing or departing aircraft.

Also installed at 45 major airports is the FAA airport surveillance radar, ASR-9. With the ASR-9, specific locations of six different precipitation intensity levels will be available for the safe routing of air traffic in and about a terminal location.

Low Level Wind Shear Alert System (LLWAS)

The Low Level Wind Shear Alert System (LLWAS) provides pilots and controllers with information on hazardous surface wind conditions (on or near the airport) that creates unsafe landing or departure conditions. LLWAS evaluates wind speed and direction from sensors on the airport periphery with center field wind data. During the time that an alert is posted, air traffic controllers provide Wind Shear Advisories to all arriving and departing aircraft.

Satellite Imagery

Visible and infrared imagery (or pictures) of clouds are taken from weather satellites in orbit. The pictures are then made available on a near real time basis to NWS and FAA facilities. Satellite pictures are an important source of weather information. For more information on satellite products, see Section 3, "Satellite Weather Pictures."

COMMUNICATION SYSTEMS

High speed communications and automated data processing have improved the flow of weather data and products through the nation's weather network. The flow of weather information within and between agencies is becoming faster as computers and satellites are being used to facilitate the exchange of data. A new computer-based Advanced Weather Interactive Processing System (AWIPS) is being developed for the Na-

tional Weather Service. This system will replace the current system and will allow quicker dissemination of weather information between NWS offices and NWS offices and their users. This system will be linked with the WSR-88D system to provide better detection, observing, and forecasting of weather systems, especially severe weather. The AWIPS network is scheduled to be in place in NWS offices by the late 1990s.

The flow of alphanumeric weather information to the FAA Service Outlets is accomplished through leased lines to computer based equipment. The NWS and FAA Service Outlets exchange weather information through the use of graphic products and alphanumeric information. Graphic products (weather maps) are received by FAA Service Outlets from NMC through a private sector contractor. Alphanumeric information exchanged through telecommunication gateways at NWS and FAA switching centers serves to pass data between the various FAA facilities, NWS, and other users.

USERS

The ultimate users of the aviation weather service are pilots and dispatchers. Maintenance personnel may use the service to keep informed of weather that could cause possible damage to unprotected aircraft. Pilots contribute to, as well as use, the service. Pilots should send PIREPs to help fellow pilots, briefers and forecasters. The service can be no better or more complete than the information that goes into it.

In the interest of safety and in compliance with Federal Aviation Regulations, all pilots should get a complete weather briefing before each flight. It is responsibility of the pilot to ensure he/she has all the information needed to make a safe flight.

Obtaining a Good Weather Briefing

When requesting a briefing, pilots should identify themselves as pilots and give clear and concise facts about their flight:

1. Type of flight VFR or IFR
2. Aircraft number or pilot's name
3. Aircraft type
4. Departure point
5. Route-of-flight
6. Destination
7. Flight altitude(s)
8. Estimated time of departure
9. Estimated time en route or estimated time of arrival

With this background, the briefer can proceed directly with the briefing and concentrate on weather relevant to the flight.

The weather information received depends on the type of briefing requested. A STANDARD briefing should include:

1. Adverse conditions (pilots may elect to cancel at this point)
2. VFR flight not recommended [FSS/AFSS briefers only]
3. Weather synopsis (positions and movements of lows, highs, fronts and other significant causes of weather)
4. Current weather
5. Forecast weather (en route and destination)
6. Forecast winds/temperatures aloft
7. Alternate routes (if any)
8. Aeronautical information (NOTAMs)
9. ATC delays
10. Request for PIREPs

An ABBREVIATED briefing will be provided at the user's request (1) to supplement mass disseminated data, (2) to update a previous briefing, or (3) to request specific information only.

An OUTLOOK briefing will be provided when the briefing is six or more hours in advance of the proposed departure. Briefing will be limited to applicable forecast data for the proposed flight.

The FSS/AFSS's purpose is to serve the aviation community. Pilots should not hesitate to ask questions and discuss factors they do not fully understand. The briefing should be considered complete only when the pilot has a clear picture of what weather to expect. It is also advantageous for the pilot to make a final weather check immediately before departure if at all possible.

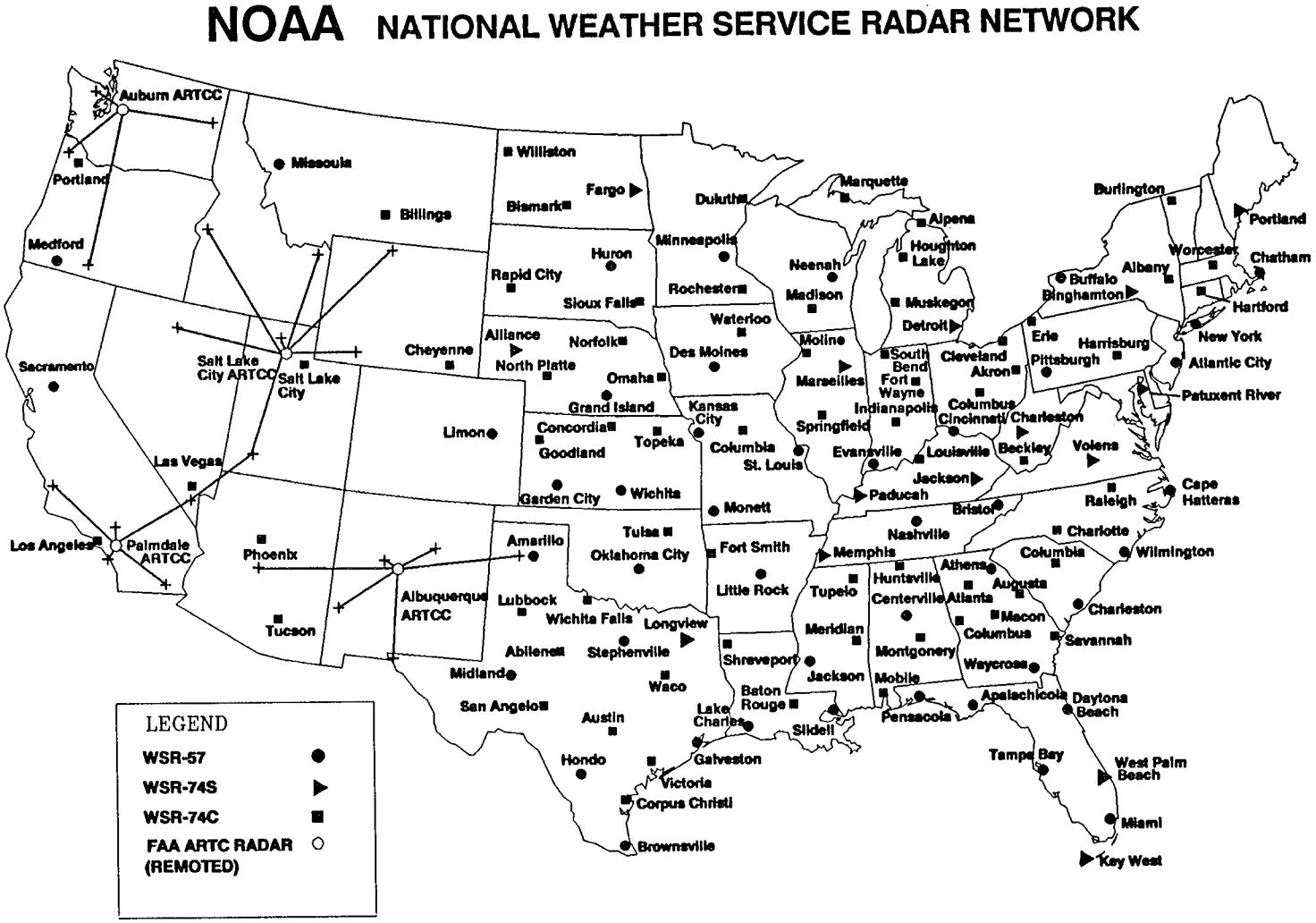


FIGURE 1-1. The Radar Observation Network.

PROPOSED WSR-88D NETWORK SITES

FIGURE 1-2. The proposed WSR-88D (DOPPLER) Radar Observing Network.

FORECAST WINDS AND TEMPERATURES ALOFT NETWORK

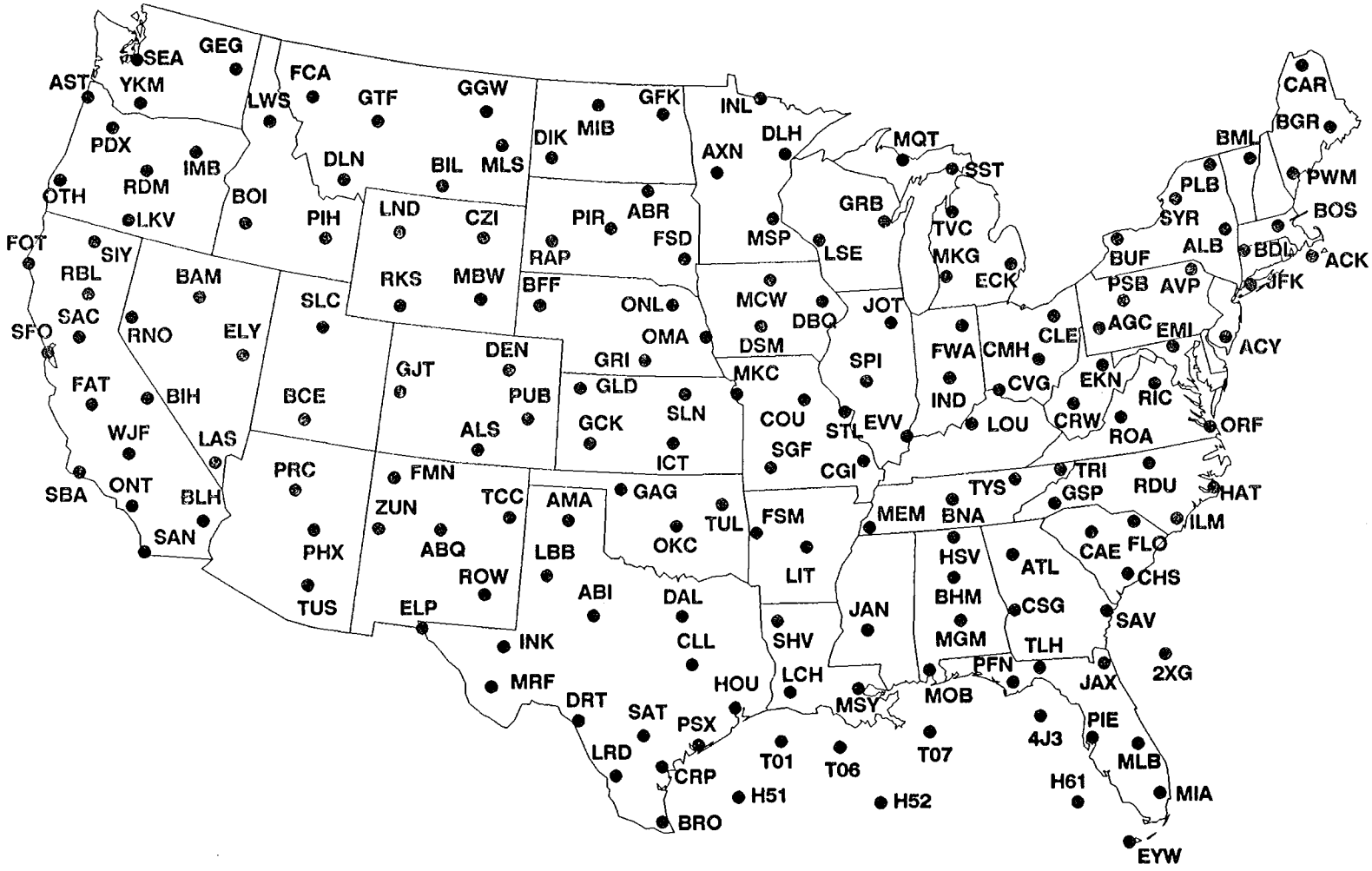
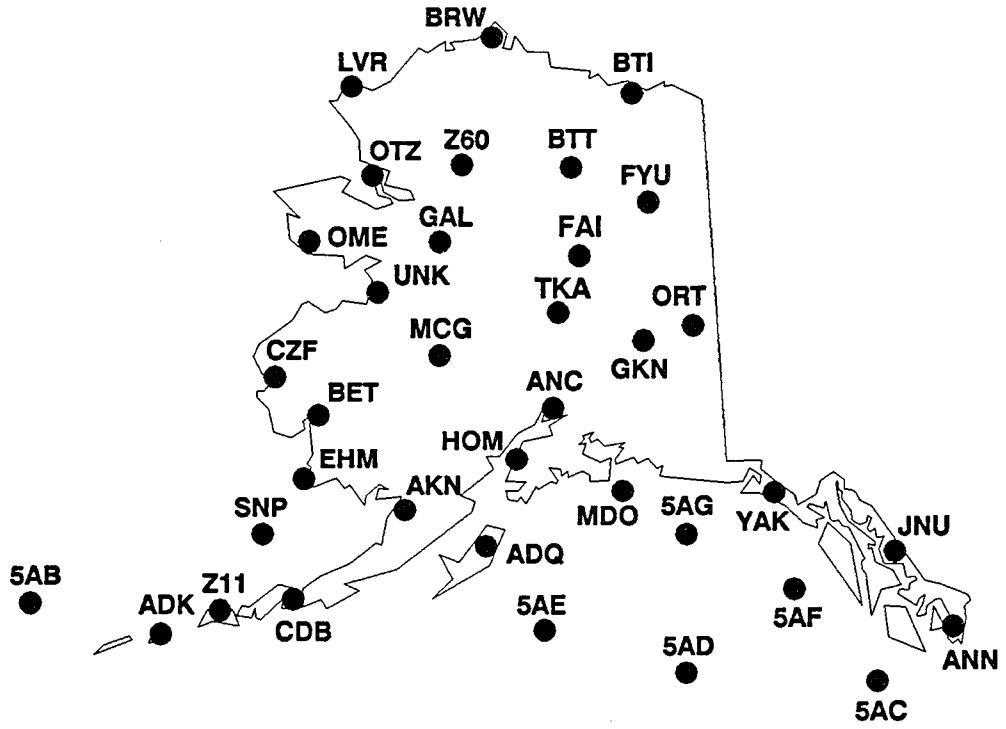


FIGURE 1-3. The forecast winds and temperatures aloft network.

ALASKA FD LOCATIONS



HAWAII FD LOCATIONS

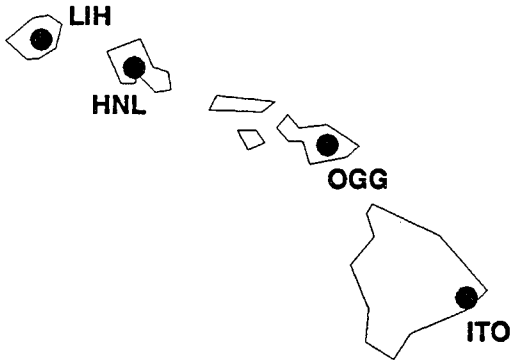


FIGURE 1-3A. The forecast winds and temperatures aloft network for Alaska and Hawaii.

AVIATION AREA FORECASTS

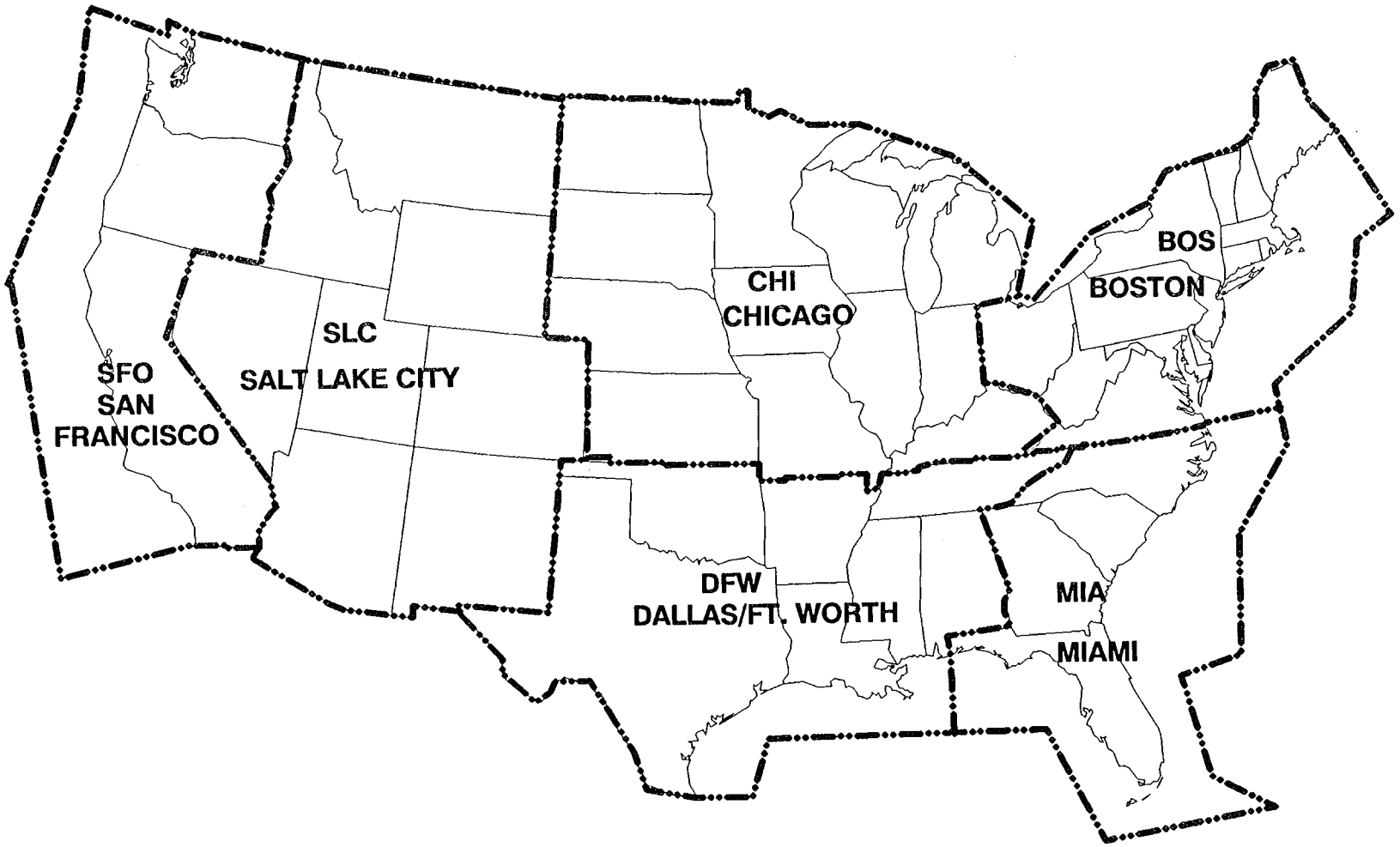
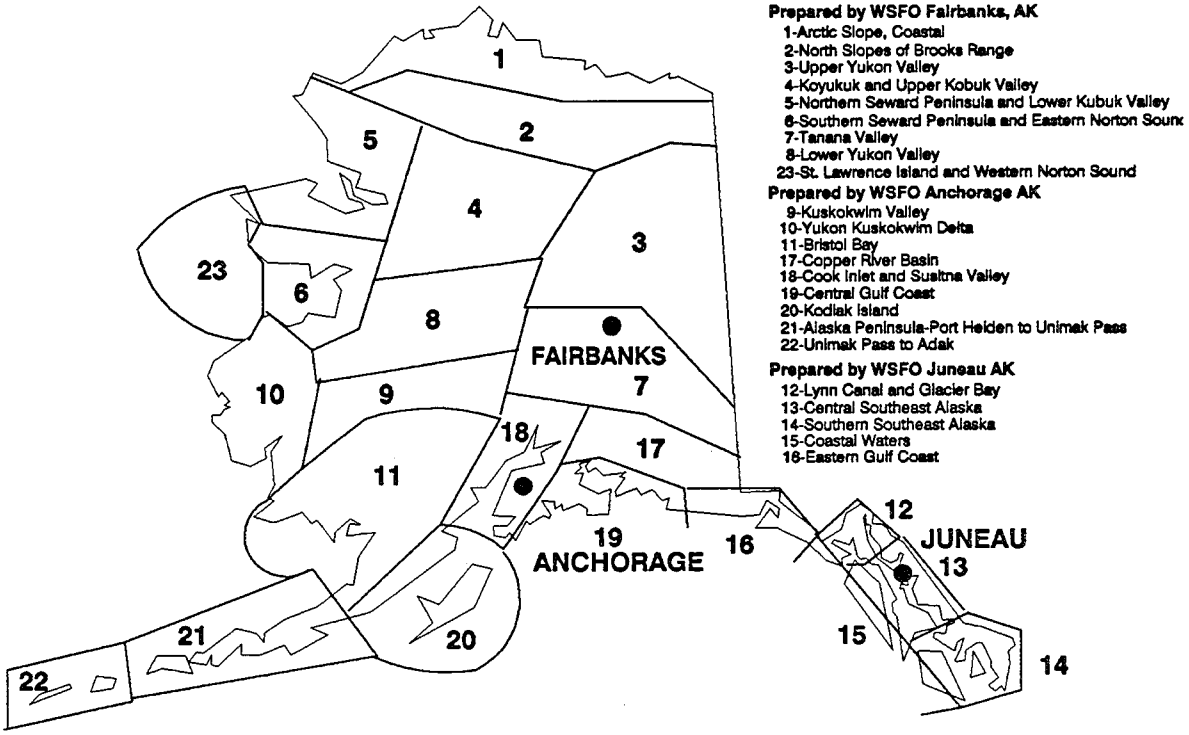


FIGURE 1-4. Locations of the area forecasts.

ALASKA AREA FORECAST SECTORS



HAWAIIAN AREA FORECAST

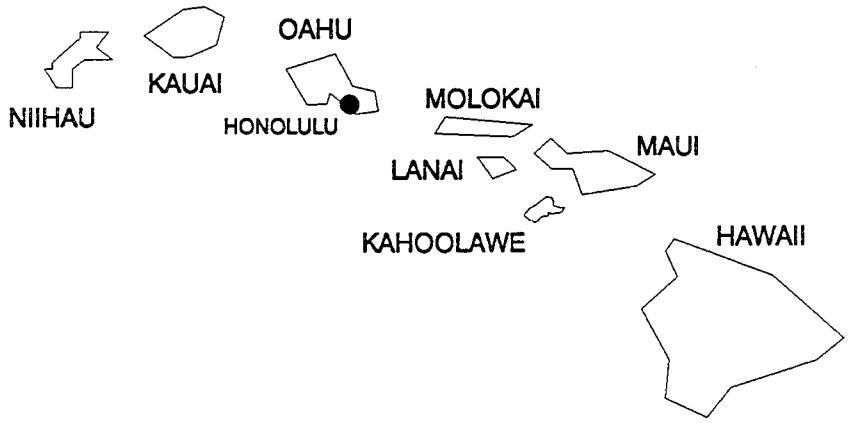


FIGURE 1-4A. Locations of the area forecasts in Alaska and Hawaii.

FIGURE 1-5. Eastern U.S. Terminal Forecast Locations

FIGURE 1-5A. Western U.S. Terminal Forecast Locations

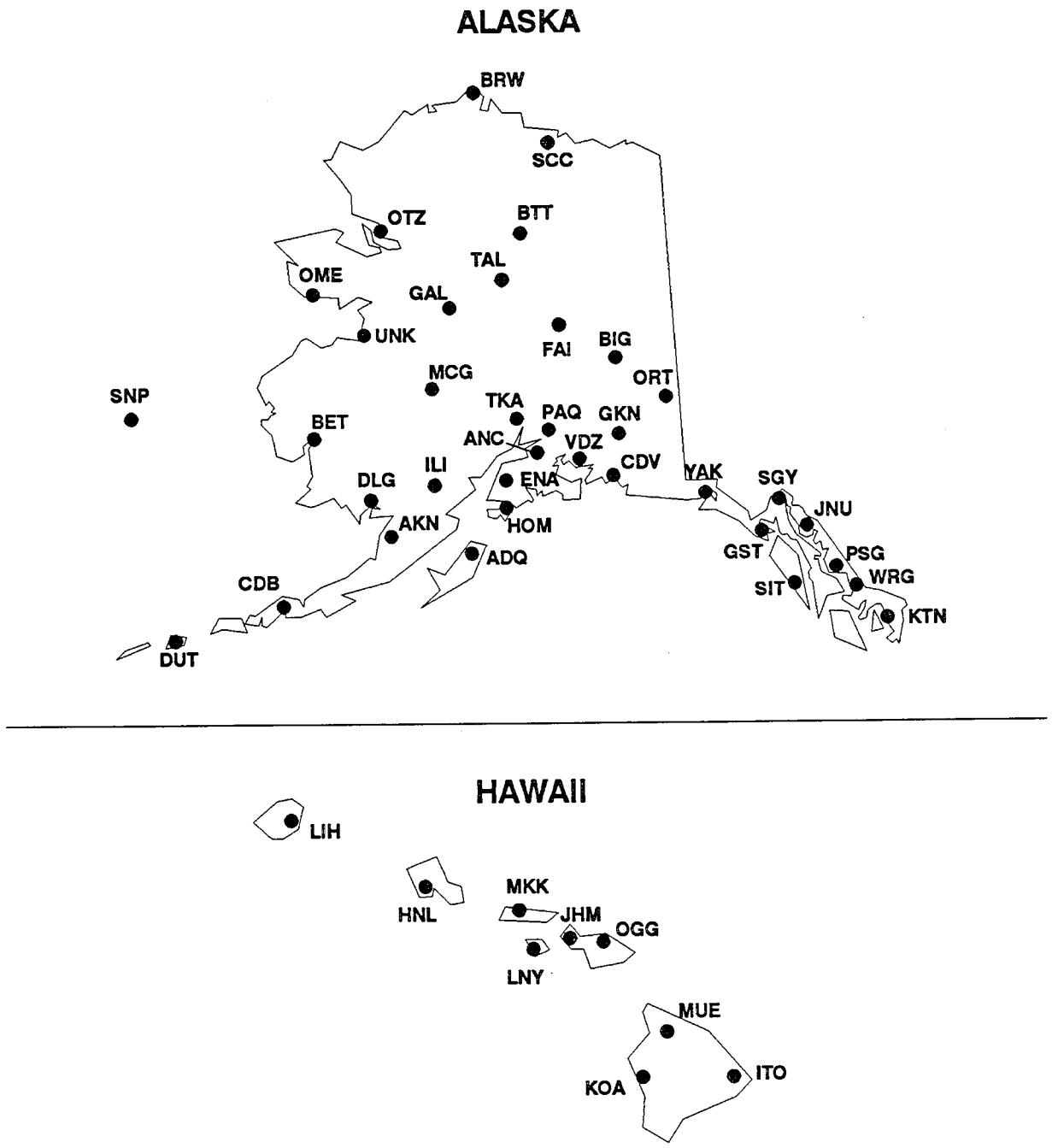


FIGURE 1-5B. Terminal Forecast Locations in Alaska and Hawaii

TWEB Route Configuration Map

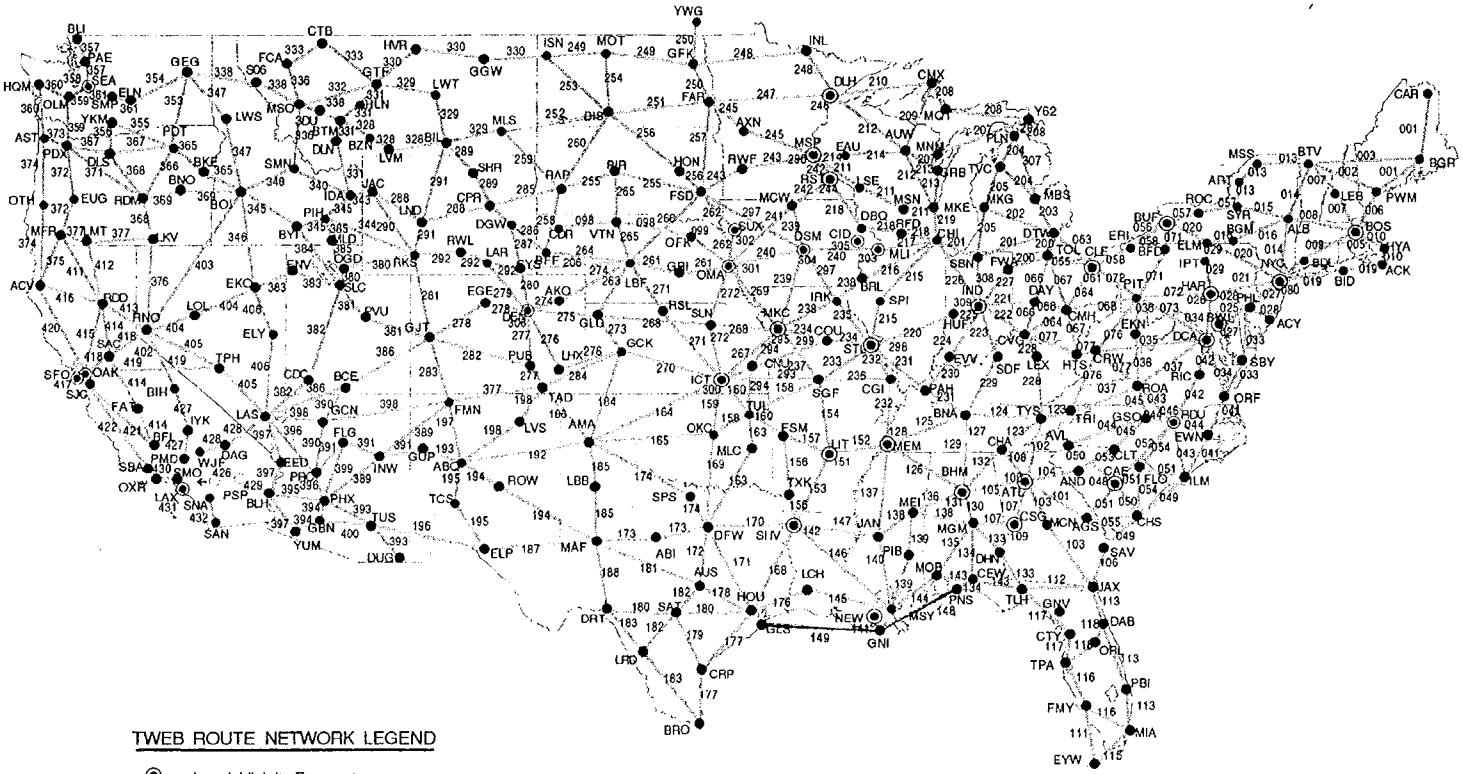


FIGURE 1-6. TWEB Forecasts Routes

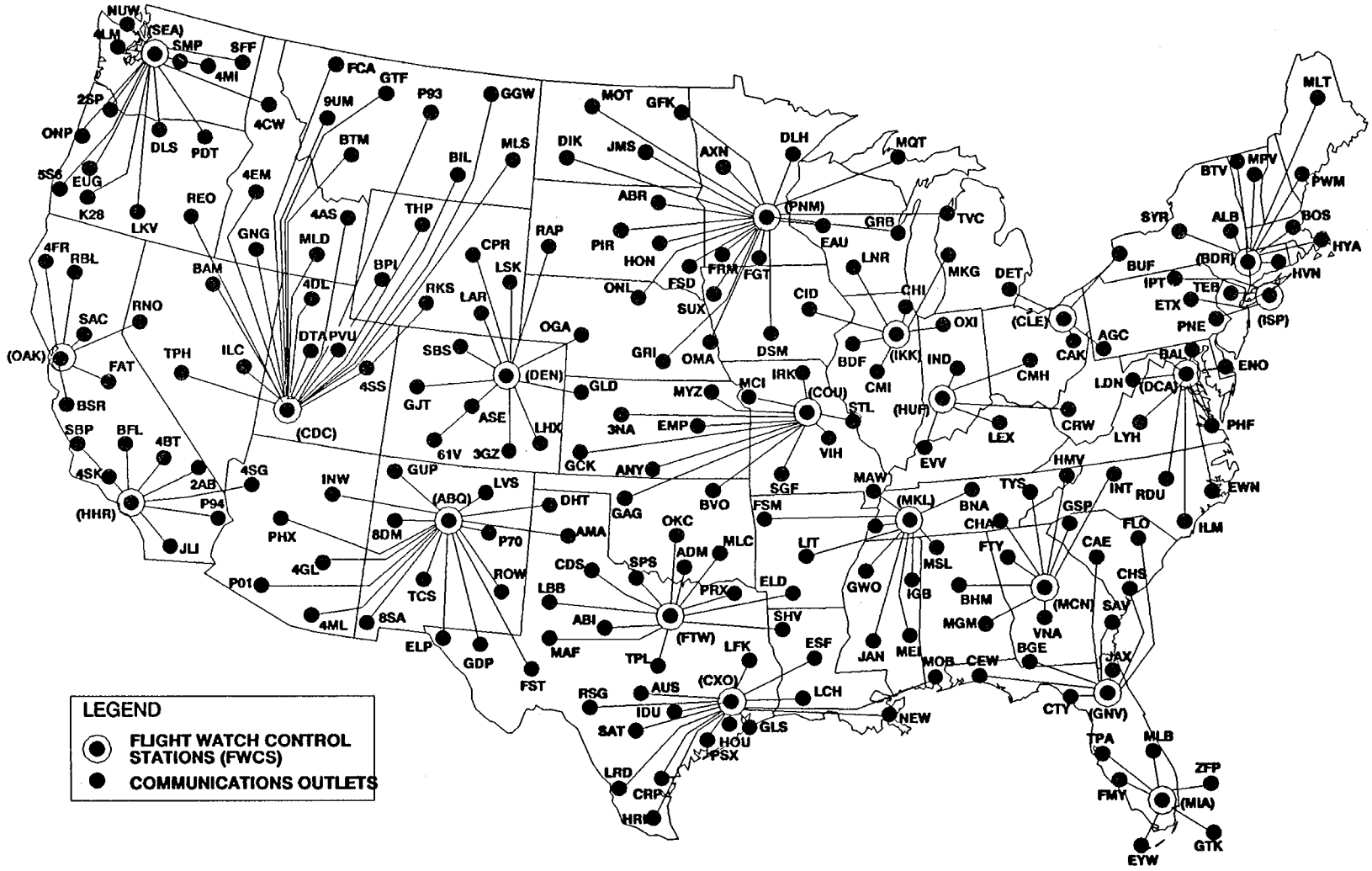


FIGURE 1-7. En Route Flight Advisory Service (EFAS) Flight Watch Facilities. An aircraft at 5,000 feet can receive a transmission to a distance of up to about 80 miles from any central or remote site.

Section 2

AVIATION WEATHER OBSERVATIONS AND REPORTS

Note: For information on an important future change in the aviation weather reporting and forecasting system, see the Aviation Routine Weather Report (METAR), page 2-10 in this section, and International Terminal Aerodrome Forecast (TAF), page 4-3 in Section 4.

When a Surface Aviation Observation (SAO) is reported and transmitted, it is a weather *report*. A SAO Report contains some or all of the following elements:

1. Station designator
2. Type and time of report
3. Type of automated observing system (if applicable. See pages 2-8 through 2-10)
4. Sky condition and ceiling
5. Visibility
6. Weather and obstructions to vision
7. Sea level pressure
8. Temperature and dew point
9. Wind direction, speed and character
10. Altimeter setting
11. Remarks and coded data

Those elements not occurring at observation time or not pertinent to the Observation are omitted from the report. When an element should be included but is unavailable, the letter "M" is transmitted in lieu of the missing element. If an element is estimated by the observer, the letter "E" will precede that element. Those elements that are included are transmitted in the above sequence.

The following five (5) **Manual Surface Aviation Observation** reports are used in discussing the above 11 elements.

INK SA 1854 CLR 10 106/77/63/1112G18/000
BOI SA 1854 150 SCT 10 181/62/42/1304/015
MDW RS 1856 -X M7 OVC 11/2R+F 990/63/61/
3205/980/RF2 RB12
JFK RS 1853 W5 X 1/4F 180/68/64/1804/006/
R04RVR22V30 TWR VSBY 1/2
LAX SP 1831 7 SCT 250 SCT 3HK 2504/991

STATION DESIGNATOR

The station designator is the three-letter identifier for the reporting station. These five reports are from Wink, TX (INK); Boise, ID (BOI); Midway Airport, Chicago, IL (MDW); John F. Kennedy Airport, New York City, NY (JFK); and Los Angeles, CA (LAX).

TYPE AND TIME OF REPORT

The two basic types of reports are:

1. Record Observation (SA), reports taken on the hour;
2. Special reports (RS or SP), observations taken as needed to report significant changes in weather.

Record Observations (SA) are transmitted in collectives and are identified by a heading. The first two reports are of this type (INK and BOI). A Record Special is a Record Observation that reports a significant change in weather. It is identified by the letters "RS" as shown in the reports from MDW and JFK. A Special "SP" is an observation taken between Record Observations to report a significant change in weather. The report from LAX is a Special Observation. Specials (SP's) do not include temperature, dew point, or wind. All reports transmitted must convey the time in Coordinated Universal Time (UTC) along with the type of Observation.

SKY CONDITION AND CEILING

A clear sky or a layer of clouds or obscuring phenomena aloft is reported by one of the first seven sky cover designators in Table 2-1. A layer is defined as clouds or obscuring phenomena aloft when the base is at approximately the same level. The height of the base of a layer precedes the sky cover designator. Height is in hundreds of feet above ground level (AGL).

Note that INK is reporting the sky clear. No height precedes the designator since no sky cover is reported. BOI reports a scattered layer at 15,000 feet above the station. Figures 2-7 and 2-8 illustrate single layers of scattered clouds.

When more than one layer is reported, layers are in ascending order of height. For each layer above a lower layer or layers, the sky cover designator for that layer will be the *total sky cover* which includes that layer and all lower layers. In other words, the summation concept of cloud layers is used. LAX reports two layers, a scattered layer at 700 feet and a higher layer at 25,000 feet. Total coverage of the two layers does not exceed 5/10 coverage, so the upper layer also is reported as scattered. Figures 2-9 and 2-10 illustrate the summation of multiple layers.

"Transparent" sky cover is clouds or obscuring phenomena aloft through which blue sky or higher sky cover is visible. As explained in Table 2-1, a scattered,

broken, or overcast layer may be reported as "thin." To be classified as thin, a layer must be half or more transparent. Remember that sky cover of a layer includes all sky cover reported below that layer. For example, if at LAX the sky had been visible through half or more of the total sky cover reported by the higher layer, the report would have been

LAX SA 1854 7 SCT 250 -SCT etc.

Any phenomenon based at the surface and hiding all or part of the sky is reported as SKY OBSCURED or SKY PARTIALLY OBSCURED (Table 2-1). An obscuration or partial obscuration may be caused by precipitation, fog, dust, blowing snow, etc. No height value precedes the designator for partial obscurations since vertical visibility is not restricted overhead. A height value precedes the designator for a total obscuration and denotes the vertical visibility into the phenomenon.

TABLE 2-1. Summary of sky cover designators

Designator	*Meaning*	*Spoken*
CLR	Clear (less than 0.1 sky cover)	CLEAR
SCT	Scattered layer Aloft (0.1 through 0.5 sky cover)	SCATTERED
BKN*	Broken Layer Aloft (0.6 through 0.9 sky cover)	BROKEN
OVC*	Overcast Layer Aloft (More than 0.9 or 1.0 sky cover)	OVERCAST
-SCT	Thin Scattered	THIN SCATTERED
-BKN	Thin Broken (At least 1/2 of the sky cover aloft is transparent at and below the level of the layer aloft.)	THIN BROKEN
-OVC	Thin Overcast	THIN OVERCAST
X*	Surface Based Obstruction (All of sky is hidden by surface based phenomena)	SKY OBSCURED
-X	Surface Based Partial Obscuration (0.1 or more, but not all, of sky is hidden by surface based phenomena)	SKY PARTIALLY OBSCURED

*Sky condition represented by this designator will constitute a ceiling layer. Descriptions in CAPITAL letters are the usual phraseology in which these reports are broadcast.

A ceiling is the height above the ground of the lowest layer of clouds or obscuring phenomena aloft that is reported as broken or overcast. This broken or overcast layer cannot be classified as "thin" nor can a surface-based obscuration be classified as "partial".

MDW reports a partial obscuration and an overcast layer at 700 feet. The overcast layer constitutes a ceiling at 700 feet. Note that the height of this ceiling layer is preceded by the letter "M." JFK reports a total obscuration of 500 feet. This height value is the vertical visibility into the obscuring phenomenon. Height of the ceiling value is preceded by the letter "W." The "M" and "W" are "ceiling designators."

A *ceiling designator* always precedes the height of the ceiling layer. Table 2-2 lists and explains ceiling designators. At MDW, the ceiling height was measured. JFK had an indefinite ceiling which was the vertical visibility into a surface-based total obscuration.

The sky cover and ceiling, as determined from the ground, represents as nearly as possible, what the pilot should experience in flight. In other words, a pilot flying at or above a reported ceiling layer should see less than half the surface below. A pilot descending through a surface-based total obscuration should first see the ground directly below from the height reported as vertical visibility into the obscuration. However, due to the differing viewing points of the pilot and the observer, the observed values and what the pilot sees do not always exactly agree. Figure 2-11 illustrates the effect of an obscured sky on the vision from a descending aircraft.

TABLE 2-2. Ceiling designators

Coded	*Meaning*	*Spoken*
M	Measured. Identifies a ceiling height for a layer aloft determined by a ceiling light, ceilometer, or based on the known height of isolated objects in contact with the ceiling layer 1 1/2 miles or less from any runway.	MEASURED CEILING
E	Estimated. Identifies a ceiling height for a layer aloft determined by any other method not meeting criteria for measured ceiling.	ESTIMATED CEILING
W	Indefinite. Vertical visibility into a surfaced based obstruction. Regardless of the method of determination, vertical visibility is classified as an indefinite ceiling.	INDEFINITE CEILING

The letter "V" appended to the ceiling height indicates a variable ceiling. The range of variability is shown in remarks. Variable ceiling is reported only when the ceiling height is below 3,000 feet. As an example,

M12V OVC and in remarks CIG 10V14
MEASURED CEILING ONE THOUSAND TWO HUNDRED VARIABLE OVERCAST, CEILING VARIABLE BETWEEN ONE THOUSAND AND ONE THOUSAND FOUR HUNDRED.

The first three elements of the five reports would be interpreted as:

INK SA 1854 CLR...
WINK, 1854 ZULU, CLEAR

BOI SA 1854 150 SCT...
BOISE, 1854 ZULU, ONE FIVE THOUSAND SCATTERED

MDW RS 1856 -X M7 OVC...
CHICAGO MIDWAY, RECORD SPECIAL, 1856
ZULU, SKY PARTIALLY OBSCURED, MEASURED
CEILING SEVEN HUNDRED OVERCAST

JFK RS 1853 W5 X...
NEW YORK KENNEDY, RECORD SPECIAL, 1853 ZULU,
INDEFINITE CEILING FIVE HUNDRED SKY OBSCURED

LAX SP 1831 7 SCT 250 SCT...
LOS ANGELES, SPECIAL 1831 ZULU, SEVEN HUNDRED
SCATTERED, TWO FIVE THOUSAND SCATTERED

VISIBILITY

Prevailing visibility immediately follows sky and ceiling in the report. Prevailing visibility is considered representative of the visibility conditions at the observing site. This representative visibility is the greatest visibility equaled or exceeded throughout at least half the horizon circle, which need not be continuous. It is reported in statute miles and fractions.

Prevailing visibilities in the five reports are:

INK...10...
WINK...VISIBILITY ONE ZERO...

BOI...10...
BOISE...VISIBILITY ONE ZERO...

MDW...11/4...
CHICAGO MIDWAY...VISIBILITY ONE AND ONE-QUARTER...

JFK...1/4...
NEW YORK KENNEDY...VISIBILITY ONE-QUARTER...

LAX...3...
LOS ANGELES...VISIBILITY THREE...

When the prevailing visibility is less than 4 miles at either or both the tower and the weather observation station, the lowest of the two observations shall be the prevailing visibility in the body of the report. The other shall be reported in remarks.

TWR VSBY 1/2
TOWER VISIBILITY ONE-HALF MILE

The letter "V" suffixed to prevailing visibility denotes a variable visibility. The range of variability is shown in remarks. Variable visibility is reported only when it is critical to aircraft operations. As an example,

3/4V and in remarks VSBY 1/2V1
VISIBILITY THREE QUARTERS VARIABLE...
VISIBILITY VARIABLE BETWEEN ONE-HALF AND ONE.

Visibility in some directions may differ significantly from prevailing visibility. These significant differences are reported in remarks. For example, prevailing visibility is reported as 1 1/2 miles with a remark,

VSBY NE 2 1/2 SW 3/4
VISIBILITY NORTHEAST TWO AND ONE-HALF, SOUTHWEST THREE-QUARTERS

WEATHER AND OBSTRUCTIONS TO VISION

Weather and obstruction to vision when occurring at the station at observation time are reported immediately following visibility. If observed at a distance from the station, they are reported in remarks.

The term *weather* refers only to those items in Table 2-3 rather than to the more general meaning of all atmospheric phenomena. Weather includes all forms of precipitation plus tornados, funnel clouds, waterspouts and thunderstorms.

TABLE 2-3. Weather symbols and meanings

Coded	*Spoken*
Tornado	TORNADO
Funnel Cloud	FUNNEL CLOUD
Waterspout	WATERSPOUT
T+	SEVERE THUNDERSTORM
T	THUNDERSTORM
R	RAIN
RW	RAIN SHOWER
L	DRIZZLE
ZR	FREEZING RAIN
ZL	FREEZING DRIZZLE
A	HAIL
IP	ICE PELLETS
IPW	ICE PELLET SHOWER
S	SNOW
SW	SNOW SHOWER
SP	SNOW PELLETS
SG	SNOW GRAINS
IC	ICE CRYSTALS

Precipitation is reported as one of three intensities. The intensity symbol follows the weather symbol:

Light	-
Moderate	(no sign)
Heavy	+

No intensity is reported for hail (A) or ice crystals (IC). A thunderstorm is reported as "T" and a severe thunderstorm as "T+." A *severe thunderstorm* is one in

which the surface wind is 50 knots or greater and/or surface hail is 3/4 inch or more in diameter.

Obstructions to vision include the phenomena listed in Table 2-4. No intensities are reported for obstructions to vision. Note: *Obstructions to vision are only reported for visibilities of 6 miles or less*. Weather symbols are used regardless of visibility. Referring back to the initial five reports, INK and BOI report no weather or obstruction to vision, therefore, no entries appear in the reports. MDW reports heavy rain (R+) as the weather and fog (F) as the obstruction to vision. JFK reports fog (F) as an obstruction to vision. LAX reports two obstructions to vision, haze (H) and smoke (K).

TABLE 2-4. Obstructions to vision-symbols and meanings

Coded	*Spoken*
BD	BLOWING DUST
BN	BLOWING SAND
BS	BLOWING SNOW
BY	BLOWING SPRAY
D	DUST
F	FOG
GF	GROUND FOG
H	HAZE
IF	ICE FOG
K	SMOKE
VOLCANIC ASH	WRITTEN OUT IN FULL

When obscuring phenomenon is surface based and partially obscures the sky, a remark reports tenths of sky hidden. For example,

K6

means 6/10 of the sky is hidden by smoke. Looking at the report from MDW, notice the remark "RF2". This means that 2/10 of the sky is hidden by rain and fog.

A layer of obscuring phenomenon aloft is reported in the sky and ceiling portion the same as a layer of cloud cover is. A remark identifies the layer as an obscuring phenomenon. For example,

20 -BKN and a remark K20 -BKN

means that a thin broken layer of smoke is based at 2,000 feet above the surface.

SEA LEVEL PRESSURE

The U.S. is in the process of converting to metric units in it's weather reports. In the metric system, "hectoPascal" is the unit of pressure measurement and replaces "millibars" in current use. The units are equivalent; i.e., one millibar equals one hectoPascal, thus 1013.2 millibars is 1013.2 hectoPascals. In this publication, both millibars and hectoPascals will be used.

Sea level pressure is separated from the preceding elements by a space and is transmitted in Record hourly reports only. It is in three digits to the nearest tenth of a millibar/hectopascal. The decimal point is omitted. Sea level pressure usually is greater than 960.0 millibars/hectoPascals and less than 1050.0 millibars/hectoPascals. The first 9 or 10 is omitted. To decode, prefix a 9 or 10, whichever brings it closer to 1000.0 millibars/hectoPascals. The sea level pressures on the five reports are:

INK 1010.6 millibars/hectoPascals
BOI 1018.1 millibars/hectoPascals
MDW 999.0 millibars/hectoPascals
JFK 1018.0 millibars/hectoPascals
LAX not reported

TEMPERATURE AND DEW POINT

Temperature and dew point are in whole degrees Fahrenheit. They are separated from sea level pressure by a slash (/). If sea level pressure is not transmitted, temperature is separated from preceding elements by a space. Temperature and dew point are separated by a slash. A minus sign precedes a temperature or dew point when below zero (0) degrees F. From our five example reports, we have:

INK...76/62...
WINK...TEMPERATURE SEVEN SIX, DEW POINT SIX TWO...

BOI...62/42...
BOISE...TEMPERATURE SIX TWO, DEW POINT FOUR TWO...

MDW...66/61...
CHICAGO MIDWAY...TEMPERATURE SIX SIX, DEW POINT SIX ONE...

JFK...68/64...
NEW YORK KENNEDY...TEMPERATURE SIX EIGHT, DEW POINT SIX FOUR...

LAX...not reported

Example with minus values:

CAR...-4/-16...
CARIBOU ME...TEMPERATURE MINUS FOUR, DEW POINT MINUS ONE SIX...

WIND

Wind follows dew point and is separated from it by a slash. The average two minute direction and speed are indicated in a four or five digit group. The first two

digits are direction *from* which the wind is blowing. It is in tens of degrees referenced to true north, i.e., 01 is 10 degrees; 21 is 210 degrees. The last two or three digits are speed in knots; two digits for speeds less than 100 knots, three digits for speeds of 100 knots or greater. A calm wind is reported as 0000.

A *gust* is a variation in wind speed of at least 10 knots between peaks and lulls. A *squall* is a sudden increase of at least 15 knots in average wind speed to a sustained speed of 20 knots or more for at least one (1) minute. Gusts or squalls are reported by the letter "G" or "Q", respectively, following the average one-minute speed and followed by the peak speed in knots. For example,

1522Q37
...WIND ONE FIVE ZERO AT TWO TWO, GUSTS IN SQUALLS THREE SEVEN...

Winds decoded from our five reports are:

INK...1112G18...
WINK...WIND ONE ONE ZERO AT ONE TWO GUSTS ONE EIGHT...

BOI...1304...
BOISE...WIND ONE THREE ZERO AT FOUR...

MDW...3205
CHICAGO MIDWAY...WIND THREE TWO ZERO AT FIVE...

JFK...1804
NEW YORK KENNEDY...WIND ONE EIGHT ZERO AT FOUR...

LAX...2504
LOS ANGELES...WIND TWO FIVE ZERO AT FOUR...

When any part of the wind report is *estimated* (direction, speed, peak speed in gusts or squalls), the letter "E" precedes the wind group. Example,

E1522G28
...ESTIMATED WIND ONE FIVE ZERO AT TWO TWO GUSTS TWO EIGHT...

A few stations do not transmit sea level pressure, temperature and dew point. When the elements are not transmitted, the wind group is separated from the preceding element by a space as in this Special Observation from Clinton-Sherman, OK:

CSM SP W5 X 2F 1705/990

ALTIMETER SETTING

Altimeter setting follows the wind group and is separated from it by a slash. Normal range of altimeter settings are from 28.00 to 31.00 inches of mercury. The last three digits are transmitted with the decimal point omitted. The altimeter setting is decoded by prefixing the coded value with either a 2 or a 3 whichever brings the value closer to 30.00 inches. The altimeter settings in the five reports are:

INK...000...
WINK...ALTIMETER THREE ZERO ZERO ZERO...

BOI...015...
BOISE...ALTIMETER THREE ZERO ONE FIVE...

MDW...980...
CHICAGO MIDWAY...ALTIMETER TWO NINER EIGHT ZERO...

JFK...006...
NEW YORK KENNEDY...ALTIMETER THREE ZERO ZERO SIX...

LAX...991...
LOS ANGELES...ALTIMETER TWO NINER NINER ONE...

REMARKS

Remarks, if any, follow the altimeter setting and are separated from it by a slash. Certain remarks should be reported routinely and others may be included by the observer when considered significant to aviation. Often, some of the most important information in an observation may be the remarks section.

The remarks are coded but generally are readable with a little practice. Clouds or weather occurring within 10 miles of the station are noted by "VCNTY STN", while clouds or weather occurring beyond 30 miles are noted by "DSNT". Between 10 and 30 miles no distance reference is given.

Runway Visibility/Runway Visual Range (RVV/RVR)

The first remark, when transmitted, is the runway visibility or runway visual range. *Runway Visibility* (RVV) is the visibility from a particular location along an identified runway and is reported in miles and fractions of miles. *Runway visual range* (RVR) is the maximum horizontal distance down a specified instrument runway at which a pilot can see to identify standard high intensity runway lights. RVR is reported in hundreds of feet.

The report consists of a runway designator and the contraction "VV" or "VR" followed by the appropriate visibility or visual range. Both the VV and the VR reports are for a 10 minute period preceding observation time. The remark usually reports the 10 minute extremes separated by the letter "V". However, if the visual range or visibility has not changed significantly during the 10 minutes, a single value is sent indicating that the value has remained constant.

The following examples show several RVV and RVR

reports and their decoding.

JFK...R04RVR22V30...
NEW YORK KENNEDY...RUNWAY FOUR RIGHT, VISUAL RANGE VARIABLE BETWEEN TWO THOUSAND TWO HUNDRED FEET AND THREE THOUSAND FEET

...R36VV11/2...
...RUNWAY THREE SIX, VISIBILITY VALUE ONE AND ONE-HALF...(VV constant during the 10 minute period.)

...R05LVV1V2...
...RUNWAY FIVE LEFT, VISIBILITY VALUE VARIABLE BETWEEN ONE AND TWO...

...R26VR24...
...RUNWAY TWO SIX, VISUAL RANGE TWO THOUSAND FOUR HUNDRED FEET...(VR constant during the 10 minute period.)

Runway visual range in excess of 6,000 feet is written 60+ and the minimum value is encoded as the minimum suffixed by a minus sign. For example,

...R36LVR10-V25...
...RUNWAY THREE SIX LEFT, VISUAL RANGE VARIABLE FROM LESS THAN ONE THOUSAND FEET TO TWO THOUSAND FIVE HUNDRED FEET...

Some examples of other remarks.

HYR CLDS VSB	Higher clouds visible
BKN V OVC	Broken variable overcast
BINOVC	Breaks in overcast
CLDS TPG MTNS SW	Clouds topping mountains southwest
RDGS OBSCD W-N	Ridges obscured west through north
ACC ALQDS*	Altocumulus castellanus all quadrants
ACSL SW-NW*	Altocumulus standing lenticular southwest through northwest
CBMAM NW*	Cumulonimbus mamma clouds northwest
VIRGA VCNTY STN E-SE*	Virga (precipitation not reaching the ground) in vicinity of the station east through southeast
TCU W*	Towering cumulus clouds west
CB DSNT N*	Cumulonimbus distant north

* These cloud types are highly significant and the observer should always report them. Figures 2-12 through 2-17 are photographs of these clouds and explain their significance. A pilot in flight should also report them when observed.

BS3	Blowing snow obscuring 3/10 of the sky
S7	Snow obscuring 7/10 of the sky
TWR VSBY 3/4	Tower visibility 3/4 mile
SFC VSBY 1/2	Surface visibility 1/2 mile
T W MOVG E	Thunderstorm west moving east
CLRG SW APCHG STN	Clearing southwest, approaching station
RB30	Rain began 30 minutes after the hour
SB15E40	Snow began 15, ended 40 minutes after the hour
T OVHD MOVG E	Thunderstorm overhead, moving east
OCNL LTG DSNT NW	Occasional lightning distant northwest
HLSTO 2	Hailstones 2 inches in diameter
INTMT R-	Intermittent light rain
OCNL RW	Occasional moderate rain shower
SNOINCR 1/8	Snow increased 1 inch in past hour and 8 inches total on ground at time of observation
R- OCNL R+	Light rain occasionally heavy rain
RWU	Rain shower of unknown intensity
KOCTY	Smoke over city
PTCHY GF S	Patchy ground fog south
WSHFT 30	Wind shifted at 30 minutes past the hour
WND 27V33	Wind variable between 270 degrees and 330 degrees
PK WND 3348/22	Peak wind within the past hour from 330 degrees at 48 knots occurred 22 minutes past the hour
PRESRR	Pressure rising rapidly
PRESFR	Pressure falling rapidly
PRJMP	Pressure jump
T DSIPTD	Thunder dissipated
FQT LTGCGCCICCA	Frequent lightning cloud to ground, cloud to cloud, in cloud, cloud to air
TWRINx	Tower in UN = unknown; C = clouds; K = smoke; H = haze; P = precipitation

FREEZING LEVEL DATA

Freezing level data (from upper air observations) is distributed by collectives. There are three collectives for the East, Central, and West sections of the country. The heading for the collectives is UXUSxx KWBC where the "xx" is 70 for the eastern collective, 71 for

the central collective, or 72 for the western collective. The code used in the collectives follows:

Stn ID Time RADAT UU (D) (hphphp)(hphphp)(/n)

Stn ID and Time - standard 3-letter identifier and observation time.
RADAT - a contraction identifying the data as "freezing level data."
UU - relative humidity at the freezing level in percent. When more than one level is sent, "UU" is the highest relative humidity observed at any of the levels transmitted.
(D) - a coded letter "L," "M," or "H". This indicates that relative humidity is for the "lowest," "middle." or "highest" level coded. This letter is omitted when only one level is sent.
(hphphp) - height in hundreds of feet above MSL at which the sounding crossed the zero degree Celsius isotherm. No more than three levels are coded. If the sounding crosses the zero degree isotherm more than three times, the levels coded are the lowest, highest and the intermediate crossing with the highest relative humidity (RH).
(/n) - indicator to show the number of crossings of the zero degree Celsius isotherm, other than those coded. The indicator is omitted when all levels are coded.

Examples (Station IDs and times omitted):

RADAT 87045	Relative humidity 87%, the only crossing of the zero degrees C isotherm was at 4,500 feet MSL.
RADAT 87L024105	Relative humidity 87% at the lowest (L) crossing. Two crossings occurred at 2,400 and 10,500 feet MSL.*
RADAT 84M019045051/1	Relative humidity 84% at the middle (M) crossing of the three-coded crossings. Coded crossings were at 1,900, 4,500 and 5,100 feet. The 84% humidity was at 4,500 feet MSL. The "/1" indicates one additional crossing.
RADAT MISG	The sounding terminated below the first crossing of the zero degree C isotherm. All temperatures were above freezing.
RADAT ZERO	The entire sounding was below zero degree C.

*The temperature was below zero degree C below 2,400 feet MSL; above zero degrees C between 2,400 feet MSL and 10,500 feet MSL; and below zero degrees C above 10,500 feet MSL.

REPORT IDENTIFIERS

Individual reports must contain the time and type of report.

Example 1, **INK SA 1100...**

indicates a relay report from Wink, TX for 1100 UTC. The "SA" signifies a Record hourly.

Example 2, **INK SA COR 1100...**

signifies a correction to the 1100 UTC Record hourly report as originally transmitted. Corrections transmitted must consist of the entire corrected observation.

Example 3, **INK SP 2315...**

indicates a Special Report of an observation taken at 2315 UTC to report a significant change in weather.

Supplemental Aviation Weather Reporting Stations (SAWRS) reports are unscheduled and are made by observers at stations not served by a regularly reporting weather station. Observations taken routinely on an hourly observation basis are encoded with an "SA." Observations taken during commercial aircraft operations and whenever mandatory special criteria are met are encoded with an "SP."

READING THE SURFACE AVIATION WEATHER REPORT

Now that we have discussed the individual elements and their decoding, let's read completely each of the reports. Capitalized phrases are those elements which *normally* are broadcast by the station at or near the airport where the observation was made:

INK SA 1854 CLR 10 106/77/63/1112G18/000

WINK, 1854 ZULU, CLEAR, VISIBILITY ONE ZERO, pressure 1010.6 millibars/hectoPascals, TEMPERATURE SEVEN SEVEN, DEW POINT SIX THREE, WIND ONE ONE ZERO AT ONE TWO GUSTS ONE EIGHT, ALTIMETER THREE ZERO ZERO ZERO.

BOI SA 1854 150 SCT 10 181/62/42/1304/015

BOISE, 1854 ZULU, ONE FIVE THOUSAND SCATTERED, VISIBILITY ONE ZERO, pressure 1018.1 millibars/hectoPascals, TEMPERATURE SIX TWO, DEW POINT FOUR TWO, WIND ONE THREE ZERO AT FOUR, ALTIMETER THREE ZERO ONE FIVE.

MDW RS 1856 -X M7 OVC 11/2R+F 990/63/61/3205/980/ RF2 RB12

CHICAGO MIDWAY, RECORD SPECIAL, 1856 ZULU, SKY PARTIALLY OBSCURED, MEASURED CEILING SEVEN HUNDRED OVERCAST, VISIBILITY ONE AND ONE-HALF, HEAVY RAIN, FOG, pressure 999.0 millibars/hectoPascals, TEMPERATURE SIX THREE, DEW POINT SIX ONE, WIND THREE TWO ZERO AT FIVE, ALTIMETER TWO NINER EIGHT ZERO, TWO TENTHS SKY OBSCURED BY RAIN AND FOG, rain began 12 minutes past the hour.

JFK RS 1853 W5 X 1/4F 180/68/64/1804/006/R04RVR22V30 TWR VSBY 1/2

NEW YORK KENNEDY, RECORD SPECIAL, 1853 ZULU, INDEFINITE CEILING FIVE HUNDRED SKY OBSCURED, VISIBILITY ONE-QUARTER, FOG, pressure 1018.0 millibars/hectoPascals, TEMPERATURE SIX EIGHT, DEW POINT SIX FOUR, WIND ONE EIGHT ZERO AT FOUR, ALTIMETER THREE ZERO ZERO SIX, RUNWAY FOUR RIGHT VISUAL RANGE VARIABLE BETWEEN TWO THOUSAND TWO HUNDRED FEET AND THREE THOUSAND FEET, TOWER VISIBILITY ONE HALF.

LAX SP 1831 7 SCT 250 SCT 3HK 2504/991

LOS ANGELES, SPECIAL, 1831 ZULU, SEVEN HUNDRED SCATTERED, TWO FIVE THOUSAND SCATTERED, VISIBILITY THREE, HAZE, SMOKE, WIND TWO FIVE ZERO AT FOUR, ALTIMETER TWO NINER NINER ONE.

AUTOMATED SURFACE OBSERVATIONS

Automated Surface Observing System (ASOS)

The Automated Surface Aviation Observing System (ASOS) is a joint effort of the NWS, FAA, and the DOD. ASOS is designed to support aviation operations, weather forecasting activities, and at the same time, support the general needs of the hydrometeorological, climatological and meteorological research communities. ASOS will provide continuous minute-by-minute observations and perform the basic observing functions necessary to generate a Surface Aviation Observation (SAO). When fully implemented ASOS will more than double the number of full-time surface aviation weather observing locations (between 900 to 1,700 locations).

While the automated system and the human may differ in their methods of data collection and interpretation, both produce an observation that is similar in form and content. For the "objective" elements such as pressure, ambient temperature, dew point temperature, wind, and precipitation accumulation, both the automated system and the observer use a fixed location and time-averaging technique. For the "subjective" elements, observers use a fixed time, spatial averaging technique to describe the visual elements (sky condition, visibility and present weather), while the automated systems use a fixed location, time-averaging technique. Although this is a fundamental change, the manual and automated techniques yield remarkably similar results within the limits of their respective capabilities.

Among the basic strengths of the ASOS observation is the fact that critical weather parameters (such as sky condition and visibility) are measured at specific locations where they are needed most. ASOS data are updated once each minute and can be accessed through a variety of media never before available from a surface observing site. Computer generated voice messages can be made available through the telephone and directly to the pilot through the ground to air radio.

All ASOS locations will prepare and disseminate SAOs. Some locations operate completely unattended with no human intervention in the generation of the observation. This type of station is designated as "AO2" in the body of the SAO message.

Other locations operate with human on-station oversight and possible intervention in the form of augmentation and/or backup of the SAO message. This type of station is designated as "AO2A" in the body of the SAO message. This means an observer is present at the ASOS location to provide general oversight of the observation. These are refered to as "augmented" sites or observations. At augmented sites, observers will include in the observation some of the weather elements and remarks that the automated systems cannot detect or generate. These elements include thunderstorms, tornados, funnel clouds, waterspouts, hail, and freezing rain (when temperatures are near freezing). Some of the remarks the observers will include are those for virga, volcanic ash, and hailstone size. Figure 2-1 is a breakdown of an ASOS observation.

The ASOS will automatically report the following surface weather elements in the SAO:

1. Sky Condition: Cloud Height in hundreds of feet and Amount (CLR, SCT, BKN, OVC) up to 12,000 feet AGL. Ceilings reported as M - measured, E - estimated, W - indefinte, X - obscured, and V - variable
2. Visibility up to 10 statute miles
3. Basic Present Weather Information (type and intensity): Rain, Snow, and Freezing Rain (R, S, and ZR). If unable to determine type of light precipitation when temperatures are near freezing, reports P-. Intensities reported in standard form ("-" for light, no symbol for moderate, "+" for heavy)
4. Obstructions to Vision: Fog, Haze
5. Pressure: Sea-level Pressure in millibars/hectoPascals, and Altimeter Setting in inches of mercury
6. Ambient Temperature, Dew Point Temperature (degrees Fahrenheit)
7. Wind: Direction (tens of degrees from true north), speed (knots), character (Gusts, Squalls), and Variability
8. Selected Significant Remarks including: variable ceiling height, visibility, and wind; tower visibility; wind shifts; peak wind; rapid pressure changes; pressure tendency; beginning and ending times of weather, temperature data; precipitation amounts; etc.

Examples of ASOS observations:

IAD SA 1455 AO2 CLR BLO 120 M 101/42/41/2804/991 $

This observation from Dulles Airport, Washington D.C., indicates at 1455 UTC no clouds below 12,000 feet were detected. The prevailing visibility was missing. The sea-level pressure was 1010.1 millibars/hectoPascals, temperature was 42 degrees F. and dew point 41 degrees F. The winds were from 280 degrees at 4 knots and the altimeter was 29.91 inches. The maintenance flag ($) is automatically appended to the

observation to indicate that the site may be in need of maintenance.

IAD RS 1755 AO2A M25 BKN 100 OVC 3TR+ 101/81/75/2820G35/991/RB50 TWR VSBY 1 PCPN 0016 52032 6035/ VSBY W 1/2

Because this ASOS is attended, a thunderstorm is reported in this SAO example. [Because thunderstorms are not reported at an unattended ASOS site, separate messages based on complementary technologies provide information on thunderstorm presence and location(s)]. This report depicts heavy rain, strong gusty winds and a rapidly rising pressure. The 52032 is an additive group denoting pressure tendency and change in the last 3 hours. The pressure change over the past 3 hours in the above observation was 3.2 millibars/hectoPascals. The manually augmented remarks are for tower visibility and lower visibility to the west. The precipitation accumulation since the last hourly SAO report is identified in the "PCPN RRRR" remark, 0.16 inch in the observation above. The 6-hour precipitation accumulation is reported in the "6RRR/" group and is 0.35 inch in the example.

Automated Weather Observing System (AWOS)

The Automated Weather Observing Systems, AWOS III, has been installed by the FAA at selected airports around the country. AWOS operates in four modes: Mode 1: Full-time Automated Operation; Mode 2: Full-time Automated Operation with Local NOTAMs; Mode 3: Full-time Automated Operation w/Manual Weather Augmentation and Local NOTAM Option; and Mode 4: Manual Operation.

The Automated Weather Observing Systems consist of automated reports of ceiling/sky conditions, visibility, temperature, dew point, wind direction/speeds/gusts, altimeter setting, and if certain conditions are met, automated remarks containing density altitude, variable visibility and variable wind direction. A precipitation accumulation sensor is included and coded for longline transmission for use by meteorologists. Automated observations are broadcast on a ground-to-air radio and made available on a telephone answering device. Selected sites will have capability to transmit observations to the Service A teletype network. Figure 2-2 is the breakdown of an AWOS message.

Examples of AWOS observations:

LBL SA 1755 AWOS CLR BLO 120 10 90/56/2008/ 017

Observation from Liberal, KS, at 1755 UTC, CLR BLO 120 indicates "Clear Below 12,000 feet," visibility 10 miles, temperature 90 degrees F., dew point 56 degrees F., wind from 200 degrees at 8 knots, altimeter 30.17 inches.

FOD SA 2255 AWOS M5 BKN 10 OVC 3/4 32/30/ 0412/980/ P005/VSBY 3/4V1 1/2 WND 02V08/ WEA: R-ZR-S-F

Observation from Fort Dodge, IA, with a precipitation accumulation report, an automated variable visibility and wind direction remark. An observer appended the manual remarks of light rain, light freezing rain, light snow and fog to the observation.

Automatic Meteorological Observing Station (AMOS)

The AMOS is a solid-state system capable of automatically observing temperature, dew point, wind direction and speed, pressure (altimeter setting), peak wind speed, and precipitation accumulation. The field sensors are tied in directly to the FAA observation network. It transmits a weather report whenever the station is polled by the circuits. At a staffed AMOS, the observer can manually enter additional information to give a more complete observation. Figure 2-3 is the breakdown of an unstaffed AMOS.

PGO SA 1051 AMOS 76/61/0308/007 PK WND 18 013 which decodes as follows:

Observation from Page, OK, at 1051 UTC, temperature 76 degrees F, dew point 61 degrees F, wind from 030 degrees at 8 knots, altimeter setting 30.07 inches, peak wind since the last hourly observation 18 knots, 13 hundredths of an inch of liquid precipitation since the last synoptic observation. Figure 2-4 is the breakdown of a staffed AMOS.

GLS SA 1352 AMOS E12 BKN 150 OVC 6TRW-F 79/77/1103/004 PK WND 15 008/TB32 NW MOVG W

This Galveston, TX, observation contains similar information to the PGO example above but with the addition of sky condition, visibility, and weather and remarks made by an observer.

Examples of a staffed AMOS observation:

GLS SA 1455 AMOS CLR 7 82/71/0311/010 PK WND 15 000

GLS SA 1555 AMOS 11 SCT E100 OVC 7 80/73/ 0706/996 PK WND 13 028/TCU ALQDS RWU SW

GLS RS 1655 AMOS 7 SCT 15 SCT E60 OVC 7R-78/75/0506/006 PK WND 12 008

Automatic Observing Station (AUTOB)

The AUTOB is an AMOS with added capability to *automatically* report sky conditions, visibility and precipitation occurrence. AUTOB is polled at 20 minute intervals. The upper limit of cloud amount and height measurements is 6,000 feet AGL. Visibility in statute miles is determined by a backscatter sensor with reportable categories of 0 to 8 (Table 2-5). If a visibility report consisting of 3 values is encountered, it is decoded as shown in the following example:

"BV786," 7 = present visibility, 8 = maximum visibility during past 10 minutes, and 6 = minimum visibility during past 10 minutes.

AUTOB may indicate no cloud layers in either a clear situation or when the sensor is unable to penetrate a surface-based obscuration. To distinguish between the two, the following rules apply. If the visibility is less than 2 miles, either partial obscuration "-X" or indefinite obscuration "WX" is reported. A "-X" implies some cloud returns and a "WX" implies no cloud returns. A vertical visibility value for "WX" is not measured. When visibility is 2 miles or greater and no cloud returns are detected a "CLR BLO 60" is used which indicates a clear sky below 6,000 feet. "E" is the ceiling designator. A maximum of 3 (lowest) cloud layers will be reported. Figure 2-5 is the breakdown of an AUTOB message. For example:

DRT SA 1448 AUTOB 25 SCT E40 OVC BV5 P 58/52/1412/995 PK WND 16 004

This Del Rio, TX, observation at 1448 UTC indicates: sky condition of two thousand five hundred scattered, ceiling four thousand overcast, surface visibility was between 4 1/2 and 5 1/2 statute miles, precipitation has occurred within 10 minutes of the observation, temperature 58 degrees F, dew point 52 degrees F, wind from 140 degrees at 12 knots, altimeter setting 29.95 inches, peak wind since the last hourly observation 16 knots, four hundredths (0.04 inches) of liquid precipitation since the last synoptic observation.

Examples of an AUTOB message:

DRT SP 1328 AUTOB CLR BLO 60 BV8 75/65/ 0905/991 PK WND 08 000

DRT SA 1348 AUTOB 25 SCT E30 OVC BV8 83/71/1408/989 PK WND 18 120

DRT SP 1428 AUTOB -X E30 OVC BV1 73/69/ 1307/000 PK WND 10 000 HYR CLDS DETECTED

A remark "HYR CLDS DETECTED" is included if clouds are detected above an overcast, with the higher clouds "HYR CLDS" being less than 6,000 feet AGL. Note that an AUTOB makes no distinction between a thin and opaque cloud layer. "E30 OVC" may be a thin overcast, but is reported as a ceiling.

Table 2-5. Reportable visibility categories.

Index of vis.	*When vis. is: (statute miles)*	*Index of vis.*	*When vis. is: (statute miles)*
0	less than 15/16	5	4 1/2 - 5 1/2
1	1 - 1 7/8	6	5 1/2 - 6 1/2
2	2 - 2 7/8	7	6 1/2 - 7 1/2
3	3 - 3 1/2	8	above 7 1/2
4	3 1/2 - 4 1/2		

Remote Automatic Meteorological Observing System (RAMOS)

The breakdown of a RAMOS message is shown in Figure 2-6. Note this is similar to the unstaffed AMOS observation, except for the 3-hour pressure change, maximum/minimum temperature, and 24-hour precipitation accumulation that is included at designated times.

AVIATION ROUTINE WEATHER REPORT (METAR)

A new international weather reporting code (METAR) is now being used by all countries of the world with the exception of the United States and Canada. **These two nations will continue to use the code previously described in this section until January 1, 1996. After that date, the new code will be used for weather reports (METAR) and forecasts (TAFs) worldwide.**

Although the METAR code is being adopted worldwide, each country is allowed to make modifications or exceptions to the code for use in their particular country, i.e., the U.S. will continue using the current units of measurement (except for temperature and dew point), rather than metric units; the U.S. will continue reporting prevailing visibility rather than lowest sector visibility. Most of the current U. S. observing procedures and policies will continue after the METAR conversion date, with the information disseminated in the METAR code and format. This publication describes how the code will appear in the United States.

A METAR report contains the following sequence of elements: (compare this with the current sequence of elements on page 2-1)

1. Type of report
2. Station designator
3. Time of report

4. Wind
5. Visibility
6. Weather and obstructions to visibility
7. Sky condition
8. Temperature and dew point
9. Altimeter setting
10. Remarks

The following paragraphs describe the elements in a METAR report.

TYPE OF REPORT

There are two types of report - the METAR which is a routine observation report and SPECI which is a Special METAR weather observation. The type of report METAR or SPECI will always appear in the report header or lead element of the report.

STATION IDENTIFIER

The METAR code uses ICAO 4-letter station identifiers. In the contiguous 48 states, the 3-letter domestic station identifier is prefixed with a "K"; i.e., the domestic identifier for Seattle is SEA while the ICAO identifier is KSEA. Elsewhere, the first two letters of the ICAO identifier indicate what region of the world and country (or state) the station is in. For Alaska, all station identifiers start with "PA"; for Hawaii, all station identifiers start with "PH". Canadian station identifiers start with "CU", "CW", "CY", and "CZ"; Mexican station identifiers start with "MM". The identifier for the western Caribbean is "M" followed by the individual country's letter; i.e., Cuba is "MU", Dominican Republic "MD", the Bahamas "MY". The identifier for the eastern Caribbean is "T" followed by the individual country's letter; i.e., Puerto Rico is "TJ". For a complete worldwide listing see ICAO Document 7910, "Location Indicators".

TIME

The time the observation is taken is transmitted as a four digit time group appended with a Z to denote Coordinated Universal Time (UTC).

Example: 1250Z.

WIND

The wind is reported as a five digit group (six digits if speed is over 99 knots). The first three digits is the direction the wind is blowing from in ten's of degrees, or "VRB" if the direction is variable. The next two digits is the speed in knots, or if over 99 knots, the next three digits. If the wind is gusty, it is reported as a "G" after the speed followed by the highest gust reported. The abbreviation "KT" is appended to denote the use of knots for wind speed.

Examples:

13008KT	wind from 130 degrees at 8 knots
08032G45KT	wind from 080 degrees at 32 knots with gusts to 45 knots.
VRB04KT	wind variable in direction at 4 knots
00000KT	wind calm
210103G130KT	wind from 210 degrees at 103 knots with gusts to 130 knots

If the wind direction is variable by 60 degrees or more and the speed is greater than 6 knots, a variable group consisting of the extremes of the wind direction separated by a "V" will follow the prevailing wind group.

Example: 32012G22KT 280V350

VISIBILITY

Visibility is reported in statute miles with "SM" appended to it.

Examples:

7SM - seven statute miles
15SM - fifteen statute miles
1/2SM - one half statute mile

Runway Visual Range (RVR), when reported, is in the format: R(runway)/(visual range)FT. The "R" identifies the group followed by the runway heading, a "/", and the visual range in feet (meters in other countries).

Example:
R32L/1200FT - runway 32 left visual range 1200 feet

WEATHER

The weather as reported in the METAR code represents a significant change in the way weather is currently reported. In METAR, weather is reported in the format:

Intensity / Proximity / Descriptor / Precipitation / Obstruction to visibility / Other

Note: the "/" above and in the following descriptions (except as the separator between the temperature and dew point) are for separation purposes in this publication and do not appear in the actual METARs.

Intensity - applies only to the first type of precipitation reported. A "-" denotes light, no symbol denotes moderate, and a "+" denotes heavy.

Proximity - applies to and reported only for weather occurring in the vicinity of the airport (between 5 and 10 miles of the center of the airport runway complex). It is denoted by the letters "VC".

Descriptor - these seven descriptors apply to the precipitation or obstructions to visibility.

TS - thunderstorm	DR - low drifting
SH - shower(s)	MI - shallow
FZ - freezing	BC - patches
BL - blowing	

Precipitation - there are eight types of precipitation in the METAR code:

RA - rain	GR - hail (> 1/4")
DZ - drizzle	GS - small hail/snow pellets
SN - snow	PE - ice pellets
SG - snow grains	IC - ice crystals

Obstructions to visibility - there are eight types of obstructing phenomena in the METAR code:

FG - fog (vsby < 5/8 mile)	PY - spray
BR - mist (vsby 5/8 - 6 mi)	SA - sand
FU - smoke	DU - dust
HZ - haze	VA - volcanic ash

Note: fog (FG) is reported only when the visibility is less than five eighths of mile otherwise mist (BR) is reported.

Other - there are five categories of other weather phenomena which are reported when they occur:

SQ - squall	SS - sandstorm
DS - duststorm	PO - dust/sand whirls
FC - funnel cloud/tornado/waterspout	

Examples:

TSRA	- thunderstorm with moderate rain
+SN	- heavy snow
-RA FG	- light rain and fog
BRHZ	- mist and haze (vsby > than 5/8 mi)
FZDZ	- freezing drizzle
VCSHRA	- rain shower in the vicinity

SKY CONDITION

The sky condition as reported in METAR represents a significant change from the way sky condition is currently reported. In METAR, sky condition is reported in the format:

Amount / Height / (Type) or Vertical Visibility

Amount - the amount of sky cover is reported in eighths of sky cover, using the contractions:

SKC - clear (no clouds)
SCT - scattered (1/8 to 4/8's of clouds)
BKN - broken (5/8's to 7/8's of clouds)
OVC - overcast (8/8's of clouds)

Note: A ceiling layer is not designated in the METAR code. For aviation purposes, the ceiling is the lowest broken or overcast layer, or vertical visibility into an obscuration. Also there is no provision for reporting thin layers in the METAR code.

Height - cloud bases are reported with three digits in hundreds of feet.

(Type) - if towering cumulus clouds (TCU) or cumulonimbus clouds (CB) are present, they are reported after the height which represents their base.

Examples:
SCT025TCU BKN080 BKN250
scattered towering cumulus at 2,500 feet, broken clouds at 8,000 feet, broken clouds at 25,000 feet.

SCT008 OVC012CB
scattered clouds at 800 feet, overcast cumulonimbus cloud at 1,200 feet

SKC clear, no clouds

Vertical Visibility - total obscurations are reported in the format "VVhhh" where VV denotes vertical visibility and "hhh" is the vertical visibility in hundred's of feet. There is no provision in the METAR code to report partial obscurations.

Example:
1/8SM FG VV006 - horizontal visibility one eighth of a mile in fog, vertical visibility six hundred feet.

TEMPERATURE/DEW POINT

Temperature and dew point are reported in a two-digit form in degrees Celsius. Temperatures below zero are prefixed with an "M".

Examples:
15/08 - temperature 15 degrees, dew point 8 degrees
00/M02 - temperature zero degrees, dew point minus 2 degrees

ALTIMETER

Altimeter settings are reported in a four-digit format

in inches of mercury prefixed with an "A" to denote the units of pressure.

Example: A2995 - twenty nine point nine five inches of mercury

REMARKS

Remarks are limited to reporting operationally significant weather, the beginning and ending times of certain weather phenomena, and low-level wind shear of significance to aircraft landing and taking off. The contraction "RMK" precedes remarks. The contraction "RE" is used to denote recent weather events. Wind shear information is denoted by "WS" followed "TKO" for takeoff or "LDG" for landing, and the runway "RW" affected.

Example: RMK REFZDZB45 WS TKO RW04R ReMarks follow, REcent weather event, FreeZing DriZzle Began at 45 minutes after the hour, Wind Shear during TaKe Off RunWay 04 Right.

Examples of METAR reports and explanation:

METAR KBNA 1250Z 33018KT 290V360 1/2SM R31/2700FT +SN BLSNFG VV008 00/M03 A2991 RMK RERAE42SNB42

METAR	routine weather report
KBNA	Nashville, TN
1250Z	time 1250 UTC
33018KT	wind from 330 degrees at 18 knots
290V360	wind direction variable between 290 degrees and 360 degrees
1/2SM	visibility one half statute mile
R31/2700FT	RVR for runway 31 is 2,700 feet
+SN	heavy snow
BLSNFG	visibility obstructed by blowing snow and fog
VV008	sky obscured with vertical visibility of 800 feet
00/M03	temperature zero degrees Celsius, dew point minus 3 degrees Celsius
A2991	altimeter setting two nine point nine one inches
RMK	remarks follow
RE	recent weather events
RAE42	rain ended 42 past the hour
SNB42	snow began 42 past the hour

METAR KSFO 1453Z VRB02KT 3SM MIBR SKC 15/12 A3012

METAR	routine weather report
KSFO	San Francisco, CA
1453Z	time 1453 UTC
VRB02KT	wind variable at 2 knots
3SM	visibility 3 statute miles
MIBR	visibility obstructed by shallow mist (ground fog)
SKC	sky clear
15/12	temperature 15 degrees Celsius, dew point 12 degrees Celsius
A3012	altimeter setting three zero point one two inches

SPECI KCVG 2228Z 28024G36KT 3/4SM +TSRA BKN008 OVC020CB 28/23 A3000 RMK RETSB24RAB24

SPECI	special weather report
KCVG	Cincinnati, OH
2228Z	time 2228 UTC
28024G36KT	wind from 280 degrees at 24 knots with gusts to 36 knots
3/4SM	visibility three fourths of a statute mile
+TSRA	thunderstorm with heavy rain
BKN008 OVC020CB	broken clouds at 800 feet, overcast cumulonimbus cloud at 2,000 feet
28/23	temperature 28 degrees Celsius, dew point 23 degrees Celsius
A3000	altimeter setting three zero point zero zero inches
RMK	remarks follow
RE	recent weather event
TSB24	thunderstorm began 24 past the hour
RAB24	rain began 24 past the hour

IAD SA 1155 AO2A CLR BLO 120 5F 101/42/41/2804/991/ 52102 70125 10060 20041

IAD	STATION IDENTIFICATION: (Dulles International Airport) Identifies report using 3 or 4 alphanumeric characters (usually airport identifier).
SA	TYPE OF REPORT: (Record) See Figure 2-3 for explanation.
1155	TIME OF REPORT: UTC
AO2A	TYPE OF STATION: Automated station with precipitation discriminator and augmentation.
CLR BLO 120	SKY AND CEILING: (No clouds were detected below 12,000 feet AGL) Determined from a laser ceilometer every 30 seconds over a 30 minute period.
5	PREVAILING VISIBILITY: (Measured visibilities equal to or greater than 5 and less than 7 statute miles). Determined from a visibility sensor once every 30 seconds and is used to compute a one-minute average. The one-minute visibility values are then averaged over a 10-minute period to determine the reported (prevailing) visibility.
F	WEATHER AND OBSTRUCTIONS TO VISION: (fog) When visibility drops below 7 statute miles, the current Dew Point Depression (DD) will be used to distinguish between Fog and Haze. If the DD is less than or equal to 4 degrees F, then F will be reported as the obstruction to vision.
101	SEA-LEVEL PRESSURE: (1010.1 millibars/hectoPascals) Only the tens, units, and tenths digits are reported. To decode, prefix the value with a 9 or 10, whichever brings the value closest to 1000 millibars/hectoPascals.
42	TEMPERATURE: (42 degrees F.) See Figure 2-3 for explanation.
41	DEW POINT: (41 degrees F.) See Figure 2-3 for explanation.
2804	WIND: (280 degrees true north at 4 knots) See Figure 2-3 for explanation. The current 2-minute average wind is computed once every 5 seconds.
991	ALTIMETER SETTING: (29.91 inches) See Figure 2-3 for explanation.
52102	PRESSURE TENDENCY, 5appp: (steadily rising, 10.2 millibars/hectoPascals higher than three hours ago.) See note on bottom of Figure 2-6.
70125	24-HOUR PRECIPITATION 7RRRR: (1.25 inches of precipitation, liquid equivalent, in the past 24 hours.)
10060	MAXIMUM TEMPERATURE 1sTTT: (60 degrees F.) The maximum temperature during the past 6 hours.
20041	MINIMUM TEMPERATURE 2sTTT: (41 degrees F.) The minimum temperature during the past 6 hours.

NOTE: Refer to *ASOS GUIDE FOR PILOTS* and the *AIRMAN'S INFORMATION MANUAL* for more information. Refer to the *AIRPORT/FACILITY DIRECTORY*, aeronautical charts, and related publications for broadcast, telephone and location data. Check "Notices to Airmen" for ASOS system status. Density Altitude will be included on voice broadcast only when 1000 or more feet above airport elevation.

FIGURE 2-1. Decoding observations from ASOS stations.

FOD SA 0055 AWOS M5 OVC 1/2 70/68/3325G30/992/ P110/WND 30V36/WEA: TRW+ T OVHD

FOD	STATION IDENTIFICATION: (Fort Dodge, IA)
SA	TYPE OF REPORT: (Record) See Figure 2-3 for explanation.
0055	TIME OF REPORT: UTC.
AWOS	AUTOMATIC STATION IDENTIFIER.
M5 OVC	SKY AND CEILING: (Measured 500 feet overcast) Determined from sensor every 30 seconds and integrated over a 30-minute sampling period.
1/2	PREVAILING VISIBILITY: (One-half statute mile) Determined from sensor outputs every 10-second intervals that are used to compute a one-minute average. The one-minute visibility values are averaged over a 10-minute period to determine the reported visibility. Visibility greater than 10 statute miles not reported.
70	TEMPERATURE: (70 degrees F.) A 5-minute average reading.
68	DEW POINT: (68 degrees F.) A 5-minute average reading.
3325G30	WIND: (330 degrees true at 25 knots, gust to 30 knots) Direction is the first two digits and is reported in tens of degrees and the second two digits is the speed. The "G" stands for wind gust and the last two digits is the highest 5-second average wind speed for the past 10 minutes.
992	ALTIMETER SETTING: (29.92 inches) See Figure 2-3 for an explanation.
P110	PRECIPITATION ACCUMULATION: (1.10 inches) The cumulative amount or liquid equivalent precipitation. Reported on each observation it is an accumulation reported to the nearest 0.01 inch in inches/tenths/hundredths and prefixed with the letter "P".
WND 30V36	AUTOMATED REMARK: (Wind direction variable between 300 degrees and 360 degrees true. Variable wind direction is reported when the wind direction varies around the reported direction by 60 degrees or more with the wind speed is 7 knots or greater.
WEA: **TRW+** **T OVHD**	MANUAL WEATHER AUGMENTATION: (Thunderstorm with heavy rain shower directly over the station) This example indicates that the weather observer at the station reports a thunderstorm with a heavy rain shower directly over the station. The data that can be added to the report is limited to thunderstorms (their intensity and direction), obstructions to visibility (dependent on the visibility being 3 miles or less) and precipitation (type and intensity).

NOTE: Refer to the *AIRMAN'S INFORMATION MANUAL* for more information. Refer to the *AIRPORT/FACILITY DIRECTORY*, aeronautical charts, and related publications for broadcast, telephone, and location data. Check *NOTICES TO AIRMEN* for AWOS system units.

FIGURE 2-2. Decoding observations from AWOS stations.

MDO SA 1548 AMOS 33/29/3606/975 PK WND 08 001

MDO	STATION IDENTIFICATION: (Middleton Island, AK) Identifies report using FAA identifiers.
SA	TYPE OF REPORT: (Record) SP = Special, SA = Record, RS = Record Special.
1548	TIME OF REPORT: Coordinated Universal Time - UTC.
AMOS	AUTOMATIC STATION IDENTIFIER.
33	TEMPERATURE: (33 degrees F.) Minus sign indicates sub-zero temperatures.
29	DEW POINT: (29 degrees F.) Minus sign indicates sub-zero temperatures.
3606	WIND: (360 degrees true at 6 knots.) Direction is first two digits and is reported in tens of degrees. To decode, add a zero to the first two digits. The last digits are speed; e.g., 2524 is 250 degrees at 24 knots.
975	ALTIMETER SETTING: (29.75 inches) The tens digits and decimal are omitted from the report. To decode, prefix a 2 or 3 to the coded value, whichever brings it closer to 30.00 inches.
PK WND 08	PEAK WIND SPEED: (8 knots) Reported speed is highest detected wind speed since last hourly observation.
001	PRECIPITATION ACCUMULATION: (0.01 inches) The amount of precipitation since the last synoptic time (00, 06, 12, 1800 UTC).

FIGURE 2-3. Decoding observations from unstaffed AMOS stations

SMP SP 0056 AMOS -X M20 BKN 7/8 L-FK 046/66/65/2723/967 PK WND 36 027/VSBY S 1/4

SMP	STATION IDENTIFICATION: (Stampede Pass, WA) Identifies report using FAA identifiers.
SP	TYPE OF REPORT: (Special) See Figure 2-3 for explanation.
0056	TIME OF REPORT: UTC
AMOS	AUTOMATIC STATION IDENTIFIER
-X M20 BKN	SKY AND CEILING: (partly obscured sky, ceiling measured 2,000 feet broken) Figures are height in 100s of feet above ground level (AGL). The letter preceding height indicates the method used to determine the height. The symbol after the height is the amount of sky cover (SCT, BKN, OVC).
7/8	PREVAILING VISIBILITY: (seven-eights statute miles)
L-FK	WEATHER AND OBSTRUCTIONS TO VISION: (Light drizzle, Fog and Smoke) The algebraic signs indicate intensity (+ heavy, - light, no symbol means moderate).
046	SEA-LEVEL PRESSURE: (1004.6 millibars/hectoPascals) Only the tens, units and tenths digits are reported. To decode, prefix the value with a 9 or 10, whichever brings the value closest to 1000 millibars/hectoPascals.
66	TEMPERATURE: (66 degrees F.) See Figure 2-3 for explanation.
65	DEW POINT: (65 degrees F.) See Figure 2-3 for explanation.
2723	WIND: (270 degrees true north at 23 knots) See Figure 2-3 for explanation.
967	ALTIMETER SETTING: (29.67 inches) See Figure 2-3 for explanation.
PK WND 36	PEAK WIND SPEED: (36 KNOTS) Highest speed detected since last hourly observation.
027	PRECIPITATION ACCUMULATION: (0.27 INCHES) Amount of precipitation received since the last synoptic observation (00, 06, 12, 1800 UTC).
VSBY S 1/4	MISCELLANEOUS REMARKS AND NOTAMs: (Visibility to the south 1/4 mile). Remarks are entered here using standard contractions.

FIGURE 2-4. Decoding observations from staffed AMOS stations.

ENV SA 1648 AUTOB E25 BKN BV7 P 33/29/3606/975/ PK WND 08 001

ENV	STATION IDENTIFICATION: (Wendover, UT) Identifies report using FAA identifiers.
SA	TYPE OF REPORT: (Record) See Figure 2-3 for explanation.
1648	TIME OF REPORT: UTC.
AUTOB	AUTOMATIC STATION IDENTIFIER.
E25 BKN	SKY AND CEILING: (Estimated 2,500 feet) Figures are height in 100s of feet above ground level (AGL). Letter preceding height indicates ceiling.
BV7	PRESENT VISIBILITY: (Visibility 7 miles) Reported in whole statute miles between 0 and 8 inclusive. (Table 2-5)
P	PRECIPITATION OCCURRENCE: (P means precipitation has occurred in the past 10 minutes).
33	TEMPERATURE: (33 degrees F.) See Figure 2-3 for explanation.
29	DEW POINT: (29 degrees F.) See Figure 2-3 for explanation.
3606	WIND: (360 degrees true at 6 knots.) See Figure 2-3 for explanation.
975	ALTIMETER SETTING: (29.75 inches) See Figure 2-3 for explanation.
PK WND 08	PEAK WIND SPEED: (8 knots) See Figure 2-3 for explanation.
001	PRECIPITATION ACCUMULATION: (0.01 inches) See Figure 2-3 for explanation.

NOTE: If no clouds are detected below 6,000 feet and the visibility is greater than 2 miles, the reported sky condition will be CLR BLO 60.

FIGURE 2-5. Decoding observations from AUTOB stations.

P67 SA 2356 RAMOS 046/66/65/2723/967 PK WND 36 0002 027 83 20043

P67	STATION IDENTIFICATION: (Lidgerwood, ND) Identifies report using FAA identifiers.
SA	TYPE OF REPORT: (Record) See Figure 2-3 for explanation.
2356	TIME OF REPORT: UTC.
RAMOS	AUTOMATIC STATION IDENTIFIER.
046	SEA-LEVEL PRESSURE: (1004.6 millibars/hectoPascals) Only the tens, units and tenths digits are reported. Prefix a 9 or 10 to the code, whichever brings the value closer to 1000 millibars/hectoPascals.
66	TEMPERATURE: (66 degrees F.) See Figure 2-3 for explanation.
65	DEW POINT: (65 degrees F.) See Figure 2-3 for explanation.
2723	WIND: (270 degrees true at 23 knots) See Figure 2-3 for explanation.
967	ALTIMETER SETTING: (29.67 inches) See Figure 2-3 for explanation.
PK WND 36	PEAK WIND SPEED: (36 knots) Reported speed is the highest detected since last hourly observation.
0002	THREE-HOUR PRESSURE CHANGE: (rising then falling, 0.2 millibars/hectoPascals higher now than three hours ago.) See note below.
027	PRECIPITATION ACCUMULATION: (0.27 inches) See Figure 2-12 for explanation.
83	TEMPERATURE: (Maximum temperature for day of 83 degrees F.) Maximum temperatures are reported at 00 and 06Z, Minimum temperatures are reported at 12 and 18Z.
20043	PRECIPITATION ACCUMULATION PAST 24-HOURS 2RRRR: (0.43 inches)

NOTE: In THREE-HOUR PRESSURE CHANGE the first digit is the barometer tendency. The tendency is higher than three hours ago if the digit is 0, 1, 2 or 3. The pressure is lower than three hours ago if the digit is 5, 6, 7 or 8 and if the digit is a 4, no change has occurred in the last three hours.

FIGURE 2-6. Decoding observations from RAMOS stations.

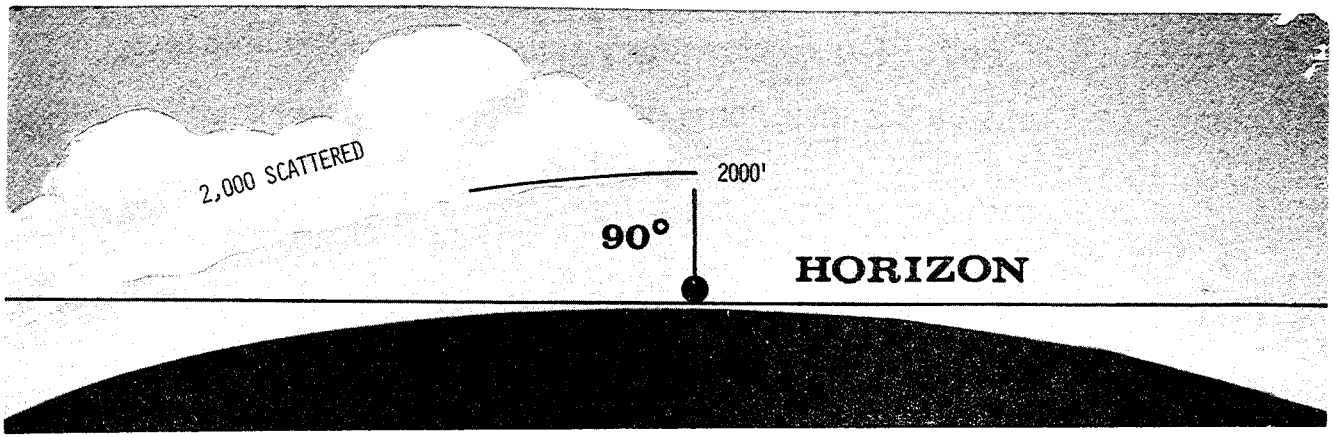


FIGURE 2-7. Scattered sky cover by a single advancing layer. Scattered is 5/10 or less sky cover (5/10 in this example).

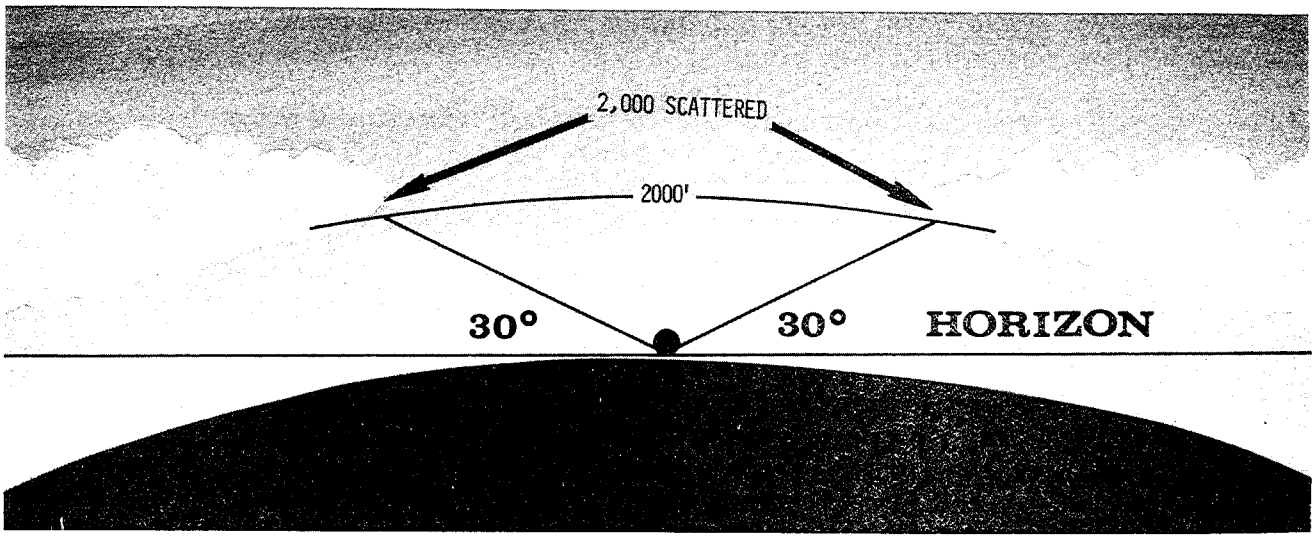


FIGURE 2-8. Scattered sky cover by a single layer surrounding the station (5/10 covered in this example).

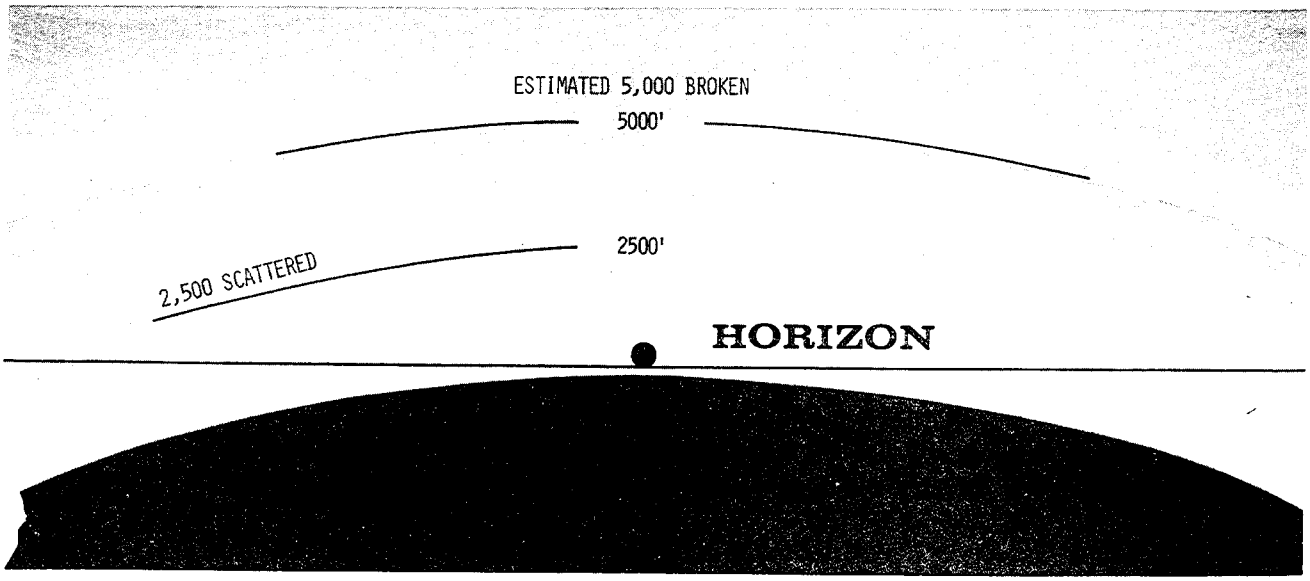


FIGURE 2-9. Summation of cloud cover in multiple layers.

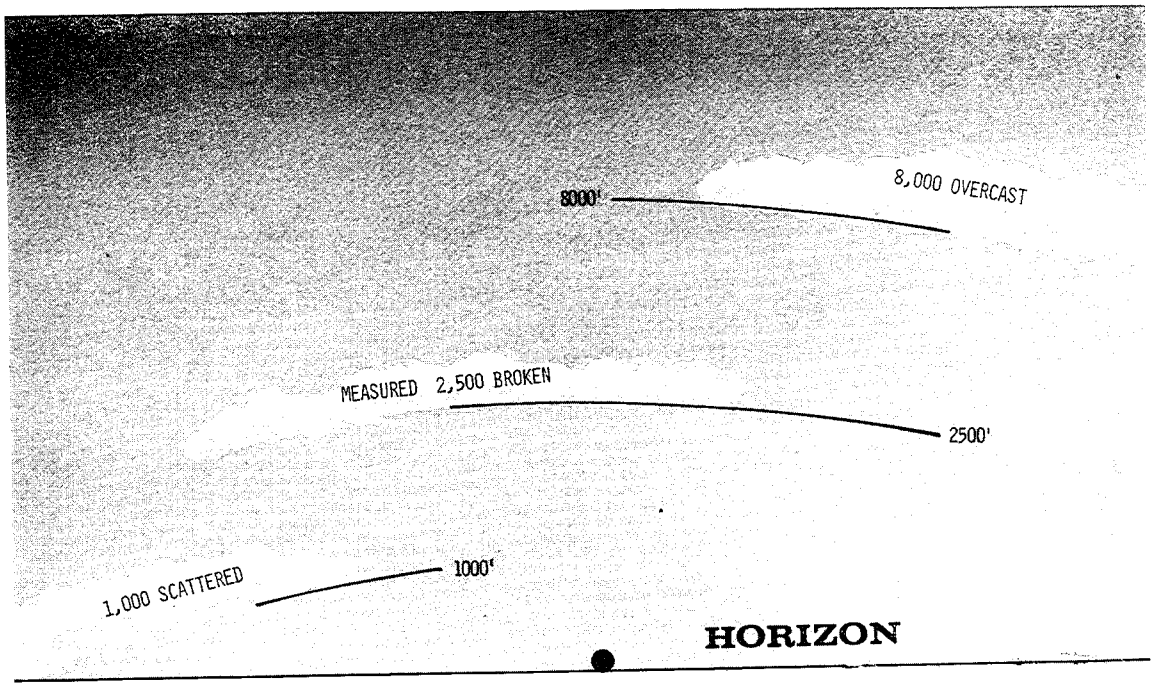


FIGURE 2-10. Summation of cloud cover in multiple layers. Note that at the height of the upper layer, sky is reported as overcast even though the upper layer itself covers less than 1/2 of the sky (10 SCT M25 BKN 80 OVC).

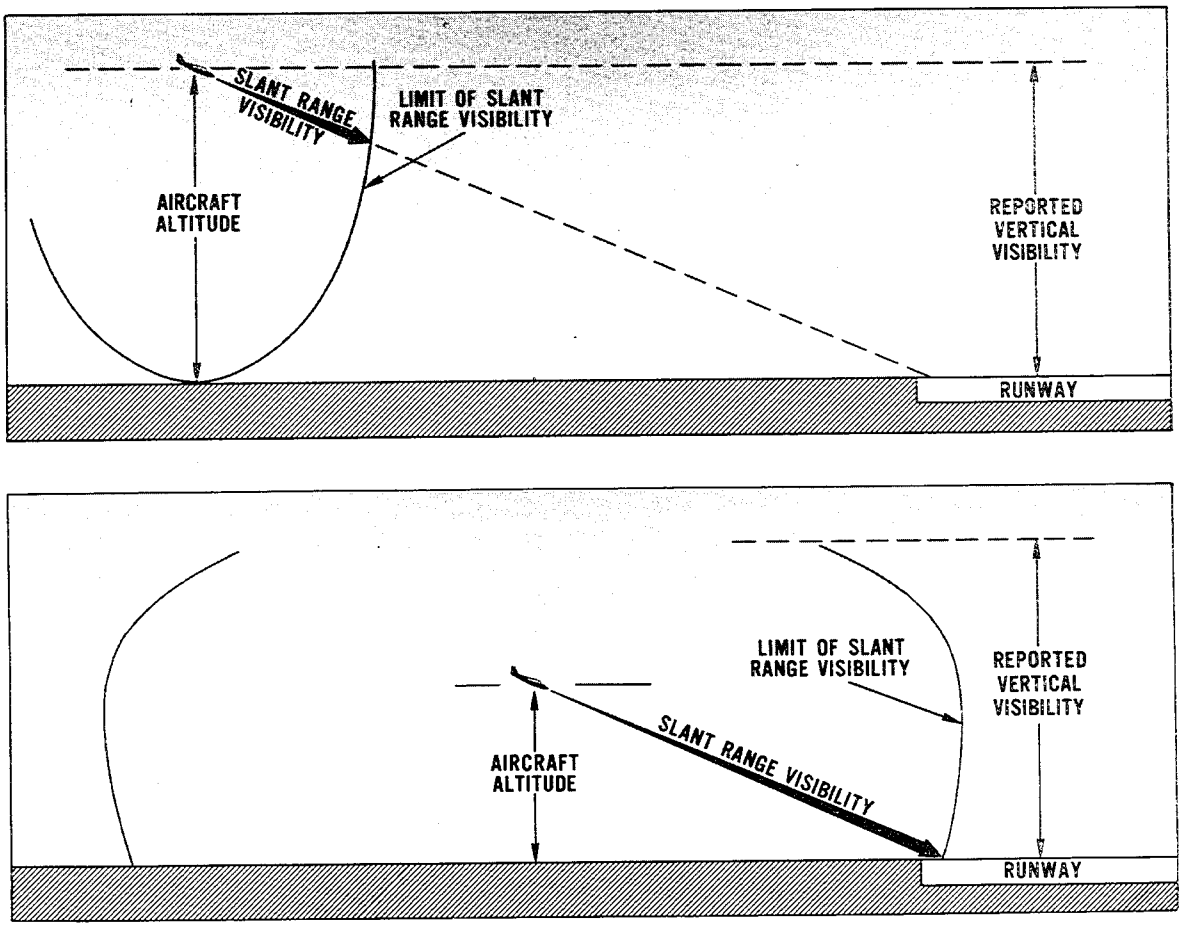


FIGURE 2-11. Vertical visibility is the altitude above the ground from which a pilot should first see the ground directly below him(top). The pilot's real concern is slant range visibility which often is less than vertical visibility. The pilot usually must descend to a lower altitude (bottom) before seeing a representative surface and can fly by visual reference to the ground.

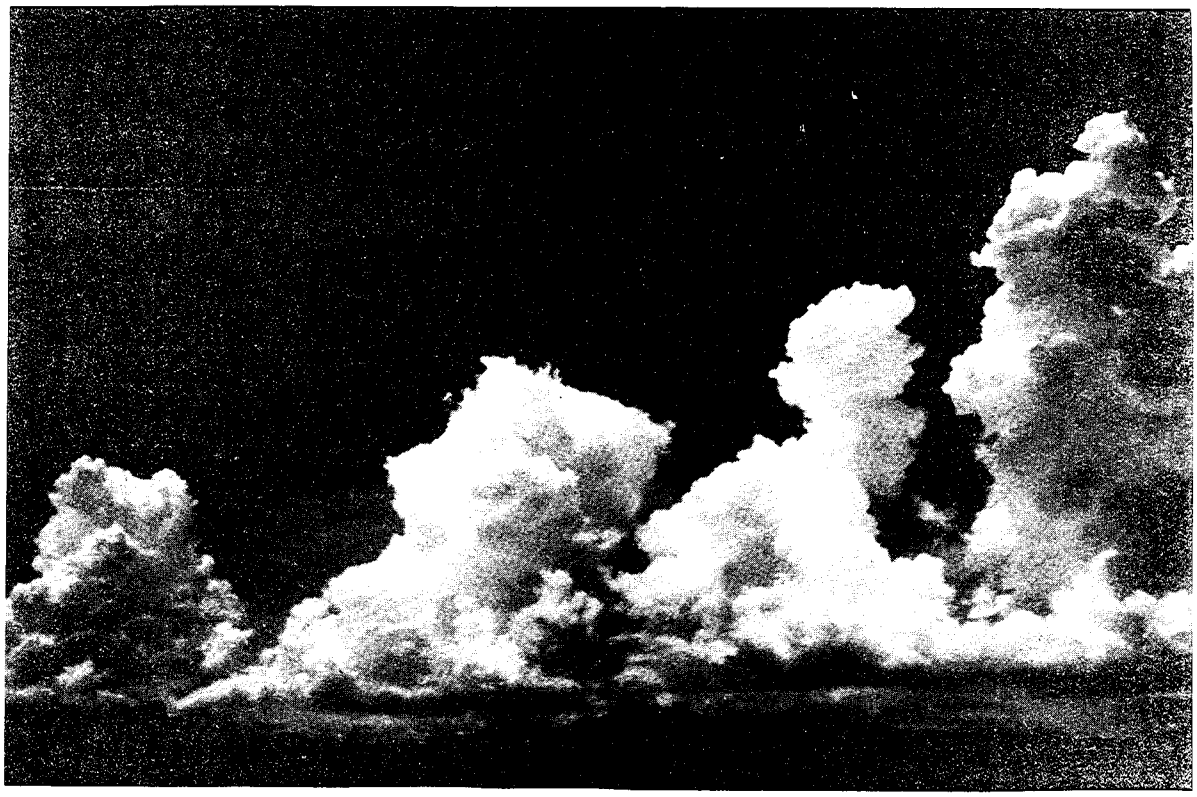


FIGURE 2-12. Towering Cumulus (TCU). The significance of this cloud is that it indicates the atmosphere in the lower altitudes is unstable and conducive to turbulence.

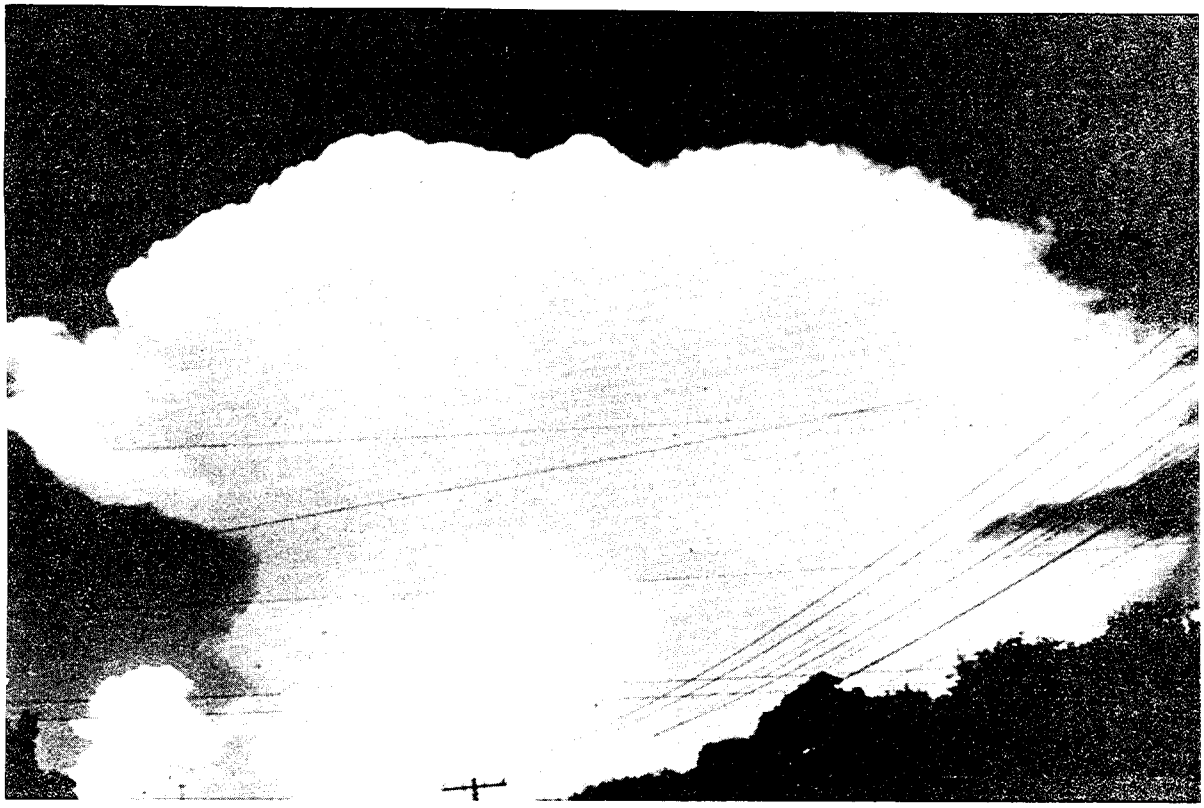


FIGURE 2-13. Cumulonimbus (CB). The anvil portion of a CB is composed of ice crystals. The CB or thunderstorm cloud contains most types of aviation weather hazards; particularly turbulence, icing, hail and low-level wind shear (LLWS).

FIGURE 2-14. Cumulonimbus Mamma (CBMAM). This characteristic cloud can result from violent up and down currents. This cloud type indicates possible severe or greater turbulence.

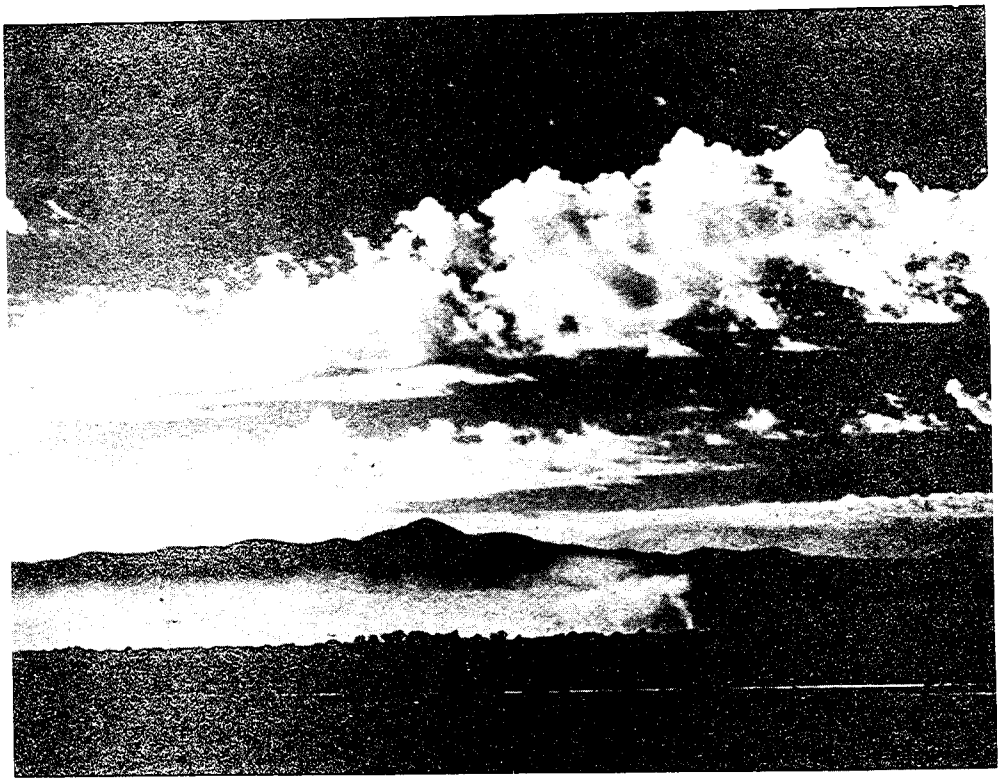


FIGURE 2-15. Altocumulus Castellanus (ACC). ACC indicates unstable conditions aloft, but not necessarily below the base of the cloud. Note in this picture a surface-based inversion shown by the trapped smoke, indicating stable conditions at the surface. Thus, rising air causing the ACC is originating somewhere above the surface-based inversion. Compare with towering cumulus, a cloud representing unstable air and turbulence from the surface upward.

FIGURE 2-16. Virga. Virga is precipitation falling from a cloud but evaporating before reaching the ground. Virga results when air below the cloud is very dry and is common in the western part of the country. Virga associated with showers suggests strong downdrafts with possible moderate or greater turbulence.

FIGURE 2-17. Standing Lenticular Altocumulus (ACSL). These clouds are characteristic of the standing or mountain wave. Similar clouds are Rotor clouds and Standing Lenticular Cirrocumulus (CCSL). The rotor clouds are usually at a lower altitude than the ACSL. CCSL are whiter and at higher altitude. All three cloud types are indicative of possible severe or greater turbulence.

Section 3

PILOT AND RADAR REPORTS AND SATELLITE PICTURES

The preceding section explained the decoding of Surface Aviation Observation reports. However, these "spot" reports are only one facet of the total current weather picture. Pilot and Radar Reports, along with satellite pictures, help to fill the gaps between stations.

PILOT WEATHER REPORTS (PIREPs)

No observation is more timely than the one made from the cockpit. In fact, aircraft in flight are the only means of directly observing cloud tops, icing, and turbulence. Other pilots welcome PIREPs as well as do the briefers and forecasters. Pilots should help themselves, the aviation public, and the aviation weather service by sending Pilot Reports.

A PIREP is usually transmitted in a prescribed format (Figure 3-1). The letters "UA" identify the message as a Pilot Report. The letters "UUA" identify an urgent PIREP. Required elements for all PIREPs are message type, location, time, flight level, type of aircraft, and at least one weather element encountered. When not required, elements without reported data are omitted. All altitude references are MSL unless otherwise noted. Distances are in nautical miles, and time is in UTC.

A PIREP is usually transmitted as an individual report but can be appended to a surface aviation weather report or placed into collectives. The phenomenon is coded in contractions and symbols. For example (refer to Figure 3-1 as a guide):

Encoding Pilot Weather Reports (PIREPS)

1. **UA** - **Routine PIREP, UUA - Urgent PIREP.**
2. **/OV** - **Location:** Use 3-letter NAVAID idents only.
   a. Fix: /OV ABC, /OV ABC 090025.
   b. Fix: /OV ABC 045020-DEF, /OV ABC-DEF-GHI.
3. **/TM** - **Time:** 4 digits in UTC: /TM 0915.
4. **/FL** - **Altitude/Flight Level:** 3 digits for hundreds of feet. If not known use UNKN: /FL095, /FL310, /FLUKN.
5. **/TP** - **Type aircraft:** 4 digits maximum, if not known use UNKN: /TP L329, /TP B727, /TP UNKN.
6. **/SK** - **Cloud Layers:** Describe as follows:
   a. Height of cloud base in hundreds of feet. If unknown, use UNKN.
   b. Cloud cover symbol.
   c. Height of cloud tops in hundreds of feet.
7. **/WX** - **Weather:** Flight visibility reported first: Use standard weather symbols, Intensity is not reported: /WX FV02 R H, /WX FV01 TRW.
8. **/TA** - **Air Temperature in Celsius:** If below zero, prefix with a hyphen: /TA 15, /TA -06.
9. **/WV** - **Wind:** Direction and speed in six digits: /WV 270045, /WV 280110
10. **/TB** - **Turbulence:** Use standard contractions for intensity and type (use CAT or CHOP when appropriate). Include altitude only if different from /FL, /TB EXTREME, /TB LGT-MDT BLO 090.
11. **/IC** - **Icing:** Describe using standard intensity and type contractions. Include altitude only if different than /FL: /IC LGT-MDT RIME, /IC SVR CLR 028-045.
12. **/RM** - **Remarks:** Use free form to clarify the report and type hazardous elements first: /RM LLWS -15 KT SFC-030 DURC RNWY 22 JFK.

Examples of completed PIREPS

UA /OV RFD 170030/TM 1315/FL160/TP PA60/SK 025 OVC 095/180 OVC/TA -21/WV 270048

UA /OV DHT 360015-AMA-CDS/TM 2116/FL050/TP PA32/SK UNKN OVC/WX FV03 R/TB LGT/TA 04/RM HVY RAIN

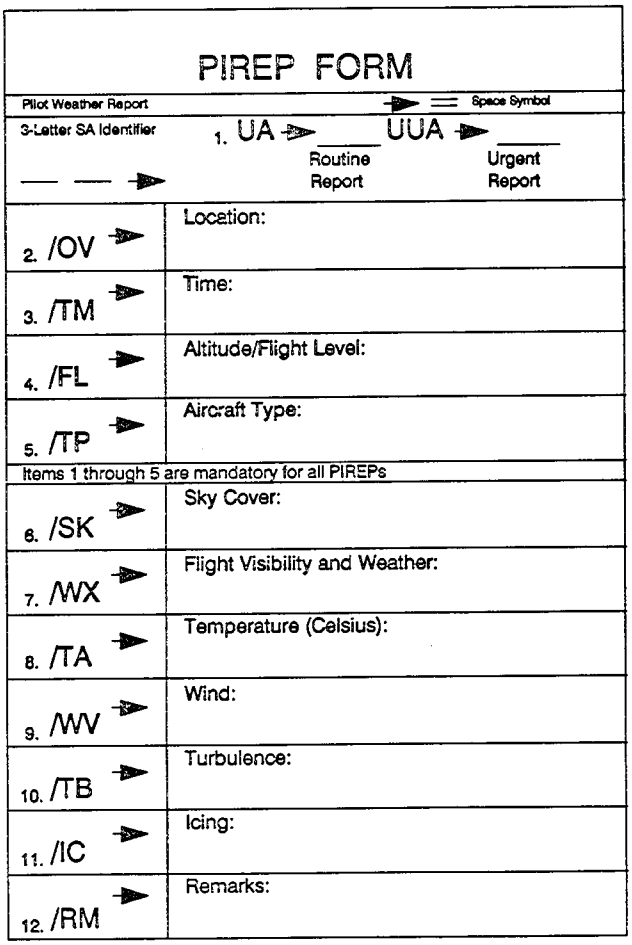


FIGURE 3-1. Pilot Report Format.

UA /OV MRB-PIT/TM 1600/FL100/TP BE55/SK 024 BKN 032/042 BKN-OVC/TA -12/IC LGT-MDT RIME 055-080/RM WND COMP HEAD 020 MH310 TAS 180.

This PIREP decodes as follows: Pilot Report, Martinsburg to Pittsburgh at 1600 UTC at 10,000 feet. Type of aircraft is a Beechcraft Baron. First cloud layer has a base at 2,400 feet broken with tops at 3,200 feet. The second cloud layer has a base at 4,200 broken occasionally overcast with no tops reported. Outside air temperature is -12 degrees Celsius. Light to moderate rime icing is reported between 5,500 and 8,000 feet. The headwind component is 20 knots. Magnetic heading is 310 degrees and the true air speed is 180 knots.

The following is an example of how a PIREP would be appended to a Surface Aviation Observation.

DSM SA 1755 M8 OVC 3R-F 132/45/44/3213/992/
UA /OV DSM 320012/TM 1735/FLUNKN/
TP UNKN /SK OVC 65/080 OVC 140.

This PIREP decodes as follows: Pilot Report, 12 nautical miles on the 320 degree radial from the Des Moines VOR, at 1735 UTC. The flight level and type of aircraft is unknown. The top of the lower overcast layer of clouds is 6,500 feet. The base of the second overcast layer is at 8,000 feet with tops at 14,000 feet.

Note that PIREPs, appended to an SAO must adhere to the same format shown in Figure 3-1.

UA /OV OKC 063064/TM 1522/FL080/TP C172/
TA -04/WV 245040/TB LGT/RM IN CLR.

This PIREP decodes as follows: Pilot Report, 64 nautical miles on the 63 degree radial from Oklahoma City VOR at 1522 UTC, flight level 8,000 feet. Type of aircraft is a Cessna 172. Outside air temperature is minus 4 degrees Celsius, wind is 245 degrees at 40 knots, light turbulence and the aircraft is in clear skies.

Most contractions in PIREP messages are self-explanatory. Icing and turbulence reports state intensities using standard terminology when possible. Intensity tables for turbulence and icing are in Section 14. If a pilot's description of an icing or turbulence encounter cannot readily be translated into standard terminology, the pilot's description is transmitted verbatim.

To lessen the chance of misinterpretation by others, report icing and turbulence in standard terminology. One PIREP stated, "...PRETTY ROUGH AT 6,500, SMOOTH AT 8,500 PA24..." A report of "light", "moderate" or "severe" turbulence at 6,500 feet would have been more understandable.

Pilot Reports of individual cloud layers, bases and tops should be reported in standard contractions. The height of a cloud base will precede the sky cover symbol and height of the cloud top will follow the symbol. For example, 038 BKN 070 means the base of a broken layer is at 3,800 feet and the top is at 7,000 feet (MSL).

Outside air temperature, in degrees Celsius, is given in 2 digits. If the temperature is below zero, the value will be preceded by a hyphen (-). Wind is given as six digits with the first 3 digits being direction and the last 3 digits being speed in knots.

The following excerpts are examples of ways to read transmitted Pilot Weather Reports:

.../RM DURD OAOI 150 OI 080...

means" ...during descent on and off instruments from 15,000 feet; on instruments from 8,000 feet...

...FL100.../TA -02/WV 250015

means" ...at 10,000 feet, temperature -2 degrees C, wind 250 degrees at 15 knots..."

...FL060/TP C172/SK INTMTLY BL/TB MDT...

means" ...at 6,000 feet, Cessna 172, intermittently between layers; moderate turbulence..."

UA/OV ABQ/TM 1845..TIJERAS PASS CLOSED DUE TO FOG AND LOW CLDS. UNABLE VFR RTNG ABQ.

is self-explanatory. Information of this type is helpful to others planning VFR flight in the area.

UA/OV TOL/TM 2200/FL 310/TP B707/TB MDT CAT 350-390

means "...over Toledo at 2200 UTC and flight level 31,000, a Boeing 707 reported moderate clear air turbulence from 35,000 to 39,000 feet.

Pilot Reports of a non-meteorological nature sometimes help air traffic controllers. This "plain language" report stated:

"...3N PNS LRG FLOCK OF GOOSEY-LOOKING BIRDS HDG GNLY NORTH MAY BE SEAGULLS FORMATION, LOUSY COURSE, ERRATIC..."

Even though in humorous vein, this PIREP alerted pilots and controllers to a bird hazard.

A PIREP always helps someone and becomes part of the aviation weather service. Pilots should report any observation that may be of concern to other pilots.

RADAR WEATHER REPORT (SD)

Thunderstorms and general areas of precipitation can be observed by radar. Most radar stations report each hour at H+35 with intervening special reports as required. The report includes the type, intensity, intensity trend and location of the precipitation. Also included is the echo top of the precipitation and if significant, the base echo. Note all heights are reported above Mean Sea Level (MSL). Table 3-1 explains symbols denoting intensity and trend. Table 3-2 shows the order and content of a Radar Weather Report.

TABLE 3-1. Precipitation intensity and intensity trend

Intensity Symbol	Intensity	Intensity Trend Symbol	Trend
-	Light	+	Increasing
(none)	Moderate		
+	Heavy	-	Decreasing
++	Very Heavy		
X	Intense	NC	No Change
XX	Extreme		
U	Unknown	NEW	New Echo

See Table 7-1 for corresponding rainfall rates defining intensities. Note that intensity and intensity trend is not applicable to frozen precipitation.

TABLE 3-2. Contents of a Radar Weather Report

```
OKC 1934 LN 8TRW++/+ 86/40 164/60 199/115 15W L2425
MT 570 AT 159/65 2 INCH HAIL RPRTD THIS CELL
^MO1 NO1 ON3 PM34 QM3 RL2 SL9=
```

```
OKC 1934   LN  8  TRW++/+  86/40 164/60 199/115
   a.      b.  c.     d.          e.

  15w     L2425      MT 570 AT 159/65
   f.       g.            h.

        2 INCH HAIL RPRTD THIS CELL
                      i.

        ^MO1 NO1 ON3 PM34 QM3 RL2 SL9=
                      j.
```

Decoding a Radar Report (using above report as example):

a. Location identifier and time of radar observation (Oklahoma City Radar Weather Report at 1934 UTC in the example)
b. Echo pattern (line in this example) - the echo pattern or configuration may be a:
   1. Line (LN) - a line of precipitation echoes at least 30 miles long, at least five times as long as it is wide and at least 30% coverage within the line.
   2. Fine Line (FINE LN) - a unique *clear air* echo (usually precipitation free and cloud free) in the form of a thin or fine line on the PPI scope. It represents a strong temperature/moisture boundary such as an advancing dry cold front.
   3. Area (AREA) - a group of echoes of similar type and not classified as a line.
   4. Spiral Band Area (SPRL BAND AREA) - an area of precipitation associated with a hurricane that takes on a spiral band configuration around the center.
   5. Single Cell (CELL) - a single isolated convective echo such as a rain shower.
   6. Layer (LYR) - an elevated layer of stratiform precipitation not reaching the ground.
c. Coverage in tenths (8/10 in this example).
d. Type, intensity and intensity trend of weather (thunderstorm (T), very heavy rainshowers (RW++) and increasing in intensity (/+) within the line in the example). See Table 7-1 for weather symbols used in a SD. See Table 3-1 for intensity and intensity trend symbols.
e. Azimuth, referenced to true north, and range, in nautical miles (NM), of points defining the echo pattern (86/40 164/60 199/115 in this echo)-See the examples that follow j. for elaboration of echo patterns.
f. Dimension of echo pattern (15 NM wide in this ex-example) - The dimension of an echo pattern is given when azimuth and range define *only* the center line of the pattern. In this example, "15W" means the line has a total width of 15 NM, 7 1/2 miles either side of a center line drawn from the points given in example "e" above.
g. Pattern movement (line moving *from* 240 degrees at 25 knots in this example) - movement of individual storms or cells "C" and area movement "A" may also be indicated.
h. Maximum top and location (57,000 feet MSL on radial 159 degrees at 65 NM in this example).
i. Remarks - self-explanatory using plain language contractions.
j. Digital section - used for preparing Radar Summary Chart.

To aid in interpreting SDs, four examples are decoded into plain language.

FAR 1133 AREA 4TRW+/+ 22/100 88/170 196/180 220/115 C2425 MT 310 AT 162/110

Fargo, ND Radar Weather Observation at 1133 UTC. An area of echoes, four-tenths coverage, contain-

ing thunderstorms and heavy rainshowers, increasing in intensity. Area is defined by points (referenced from FAR radar site) at 22 degrees, 100 NM; 88 degrees, 170 NM; 196 degrees, 180 NM and 220 degrees, 115 NM. These points, plotted on a map and connected with straight lines, outline the area of echoes. The thunderstorm cells are moving from 240 degrees at 25 knots. Maximum top (MT) is 31,000 feet MSL located at 162 degrees and 110 NM from FAR.

NPA 1935 SPL LN 1CTRWX/NC 86/40 164/60 199/115 12W C2430 MT 440 AT 159/65 D10

Pensacola, FL Special Radar Weather Report at 1935 UTC. A line of echoes, ten-tenths coverage, thunderstorm, intense rainshowers, no change in intensity. The center of the line extends from 86 degrees, 40 NM; 164 degrees, 60 NM to 199 degrees, 115 NM. The line is 12 NM wide (12W). NOTE: To display graphically, plot the center points on a map and connect the points with a straight line; since the thunderstorm line is 12 miles wide, it extends 6 miles either side of your plotted line. The thunderstorm cells are moving from 240 degrees at 30 knots. The maximum top is 44,000 feet MSL at 159 degrees, 65 NM from NPA. The diameter of this thunderstorm is 10 NM.

MFR 1130 AREA 2S 27/80 90/125 196/50 268/100 A2410 MT U100

Medford, OR Radar Weather Report at 1130 UTC. An area, two-tenths coverage, of snow (no intensities or trend is assigned for non-liquid precipitation). The area is bounded by points 27 degrees, 80 NM; 90 degrees, 125 NM; 196 degrees, 50 NM and 268 degrees, 100 NM. Area movement is from 240 degrees at 10 knots. Maximum tops are 10,000 feet MSL, tops are uniform (smooth). Note that these are precipitation tops and not cloud tops.

MAF 1132 AREA 2TRW++6R-/NC 67/130 308/45 105W C2240 MT 380 AT 66/54

Midland, TX Radar Weather Report at 1132 UTC. An area of echoes, total coverage eight-tenths, containing two-tenths coverage of thunderstorms with very heavy rainshowers and six-tenths coverage of light rain. No change in intensity. (This suggests that the thunderstorms are embedded in an area of light rain.). Although the pattern is an "area", only two points are given followed by "105W". This means the area lies 52 and 1/2 miles either side of the line defined by the two points...67 degrees, 130 NM and 308 degrees, 45 NM.

When a Radar Weather Report is transmitted, but doesn't contain any encoded weather observation, a contraction is sent which indicates the operational status of the radar. For example,

OKC 1135 PPINE

means Oklahoma City, OK's radar at 1135 UTC detects no echoes.

TABLE 3-3. Contractions of Radar Operational Status.

Contraction	Operational status
PPINE	Equipment normal and operating in PPI (Plan Position Indicator) mode; no echoes observed.
PPIOM	Radar inoperative or out-of-service for preventative maintenance.
PPINA	Observations not available for reasons other than PPINE or PPIOM.
ROBEPS	Radar operating below performance standards.
ARNO	"A" scope or azimuth/range indicator inoperative.
RHINO	Radar cannot be operated in RHI (Range-height indicator) mode. Height data not Available.

A Radar Weather Report may contain remarks in addition to the coded observation. Certain types of severe storms may produce distinctive patterns on the radar scope. For example, a "hook-shaped echo" may be associated with a tornado. A "line echo wave pattern" (LEWP) in which one portion of a squall line bulges out ahead of the rest of the line may produce strong gusty winds at the bulge. A "vault" on the Range-Height Indicator scope may be associated with a severe thunderstorm that is producing large hail and strong gusty winds at the surface. If hail, strong winds, tornado activity, or other adverse weather is known to be associated with identified echoes on the radar scope, the location and type of phenomenon are included as a remark. Examples of remarks are "HAIL REPORTED THIS CELL," "TORNADO ON GROUND AT 338/15" AND "HOOK ECHO 243/18". As far as indicating precipitation not reaching the ground, two commonly used contractions are "MALF" and "PALF". These two contractions mean that the precipitation is "mostly aloft" and "partly aloft," respectively. That is, most or some of the precipitation is not reaching the ground. Bases of the precipitation will be reported in hundreds of feet MSL. For example, "PALF BASE 040" means part of the precipitation detected is evaporating at 4,000 feet MSL.

Radar Weather Reports also contain groups of digits. For example,

^MO1 NO1 ON3 PM34 QM3 RL2 SL9=

These groups of digits are the final entry on the SD.

This digitized radar information is used primarily by meteorologists and hydrologists for estimating amount of rainfall and in preparing the Radar Summary Chart. However, this code is useful in determining more precisely where the precipitation is occurring within an area and the intensity of the precipitation by using a proper grid overlay chart for the corresponding radar site. See Figure 3-3 for an example of a digital code plotted from the Oklahoma City, OK, SD.

The digit assigned to a box represents encoded intensity levels of the precipitation as determined by a video integrator processor VIP. See Table 7-2 for definitions of intensity levels 1 through 6. Thus, the term VIP LEVEL 1 simply means the precipitation intensity is weak or light, VIP LEVEL 2 is moderate, etc. Note that the *maximum* VIP LEVEL is encoded for any given box on the grid identified in the digital code.

A box is identified by two letters, the first representing the row in which the box is found and the second letter representing the column. For example "MO1" identifies the box located in row M and column O as containing precipitation with a maximum VIP LEVEL of one (1). A code of "MO1234" indicates precipitation in four consecutive boxes in the same row. Working from left to right box MO = 1, box MP = 2, MQ = 3 and box MR = 4.

When using hourly and Special Radar Weather Reports in preflight planning, note the location and coverage of echoes, the type of weather reported, the intensity trend and especially the direction of movement.

A WORD OF CAUTION - remember that when the National Weather Service radar detects objects in the atmosphere it only detects those of precipitation size or larger. It is <u>not</u> designed to detect ceilings and restrictions to visibility. An area may be blanketed with fog or low stratus but unless precipitation is also present, the radar scope will be clear of echoes. Pilots should use Radar Reports along with SDs, SAO Reports and Forecasts when planning a flight.

Radar Weather Reports help pilots to plan ahead to avoid thunderstorm areas. Once airborne, however, they must depend on visual sighting or airborne radar to evade individual storms.

Another product provided for the use of the pilot in flight planning is an alphanumeric digital plot (Figure 3-2). The digital plot may be obtained through the request/reply circuit. The chart has digitized intensities plotted over a section map of several states. The numbers on the plot refer to "radar" intensity and represent the strongest return found in the area. From this plot the briefer/pilot may obtain the location of the strongest "radar" returns in the area of interest.

Figure 3-2 shows the plotted intensities for the area of south Texas. The dots represent the state outline.

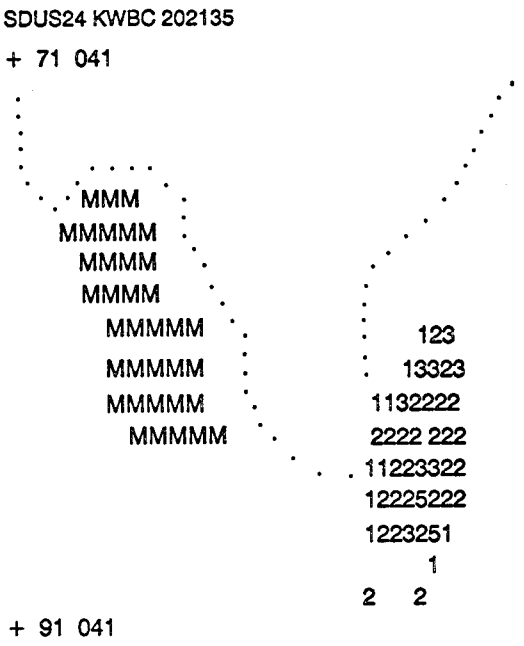


FIGURE 3-2. Digital Plot of Echo Intensities for the South Central U.S. Note: See Table 7-1 for Intensity Level Codes 1-6.
M = Missing
8 = Echoes of unknown intensity but believed to be severe.
9 = Echoes of unknown intensity but not believed to be severe.
NOTE: Echoes encoded as 8 or 9 are beyond 125 NM.

SATELLITE WEATHER PICTURES

Prior to weather satellites, weather observations were made only at distinct points within the atmosphere and supplemented by pilot observations (PIREPs). These PIREPs gave a "sense" of weather as viewed from above. However, with the advent of weather satellites, a whole new dimension to weather observing and reporting has emerged. There are two types of weather satellites in use today: GOES (a geostationary satellite) and NOAA (a polar orbiter satellite).

Two U.S. GOES satellites are used for imaging. One is stationed over the equator at 75 degrees west latitude and is referred to as GOES EAST since it covers the eastern U.S. The other is positioned at 135 degrees west latitude and is referred to as GOES WEST since it covers the western U.S. Together they cover North and South America and surrounding waters. They normally transmit an image of the earth, pole to pole, each half hour. When disastrous weather threatens the U.S., the satellites can scan small areas rapidly so that a picture can be received as often as every three minutes. Data from these rapid scans are used at national warning centers.

However, since the GOES satellite is stationary over the equator, the images poleward of about 50 degrees latitude become greatly distorted. For images above 50

degrees latitude, polar orbiting satellites are employed. The NOAA satellite is a polar orbiter and orbits the earth on a track which nearly crosses the North and South poles. A high resolution picture is produced about 500 miles either side of its track on the journey from pole to pole. The NOAA pictures are essential to weather personnel in Alaska and Canada.

Basically, two types of imagery are available, and when combined, give a great deal of information about clouds. Through interpretation, the analyst can determine, the type of cloud, the temperature of cloud tops (from this the approximate height of the cloud can be determined) and the thickness of cloud layers. From this information, the analyst gets a good idea of the associated weather.

One type of imagery is visible imagery (Figure 3-4). With a visible picture, we are looking at clouds and the earth reflecting sunlight to the satellite sensor. The greater the reflected sunlight reaching the sensor, the whiter the object is on the picture. The amount of reflectivity reaching the sensor depends upon the height, thickness, and ability of the object to reflect sunlight. Since clouds are much more reflective than most of the earth, clouds will usually show up white on the picture, especially thick clouds. Thus, the visible picture is primarily used to determine 1) the presence of clouds and 2) the type of cloud from shape and texture. Due to the obvious lack of sunlight, there are no visible pictures available from the GOES satellite at night.

The second type of imagery is infra-red (IR) imagery (Figure 3-5). With an IR picture we are looking at heat radiation being emitted by the clouds and earth. The images show temperature differences between cloud tops and the ground, as well as, temperature gradations of cloud tops and along the earth's surface. Ordinarily, cold temperatures are displayed as light gray or white. High clouds appear the whitest. However, various computer-generated enhancements are sometimes used to sharply illustrate important temperature changes. IR images are used to determine cloud top temperatures which can approximate the height of the cloud. From this, one can see the importance of using visible and IR imagery together when interpreting clouds. IR images are available both day and night.

Operationally, images are received once every 30 minutes. The development and dissipation of weather can be seen and followed over the entire country and coastal regions from imagery use.

NOTE: At the time of this revision, GOES East (75 degrees west longitude) has become inoperative and GOES West is the only U.S. satellite providing geosynchronous imagery of the U.S. During the summer and fall it is positioned so as to provide coverage of the eastern U.S. during the time the tropical weather season is most active. During the winter and spring, GOES West is re-positioned further west to provide coverage of the winter Pacific storms moving onshore on the west coast. This moving from one position to another provides less than optimal coverage of portions of the U.S. during different seasons of the year, but is necessary in order to cover as much of the U.S. as possible. In addition to satellite information from NOAA polar orbiters, the Europeans have loaned a geostationary satellite located at 50 degrees west (expected to be moved to 75 degrees west in early 1994).

The next generation of U.S. GOES satellites will be sent aloft in the mid 1990s.

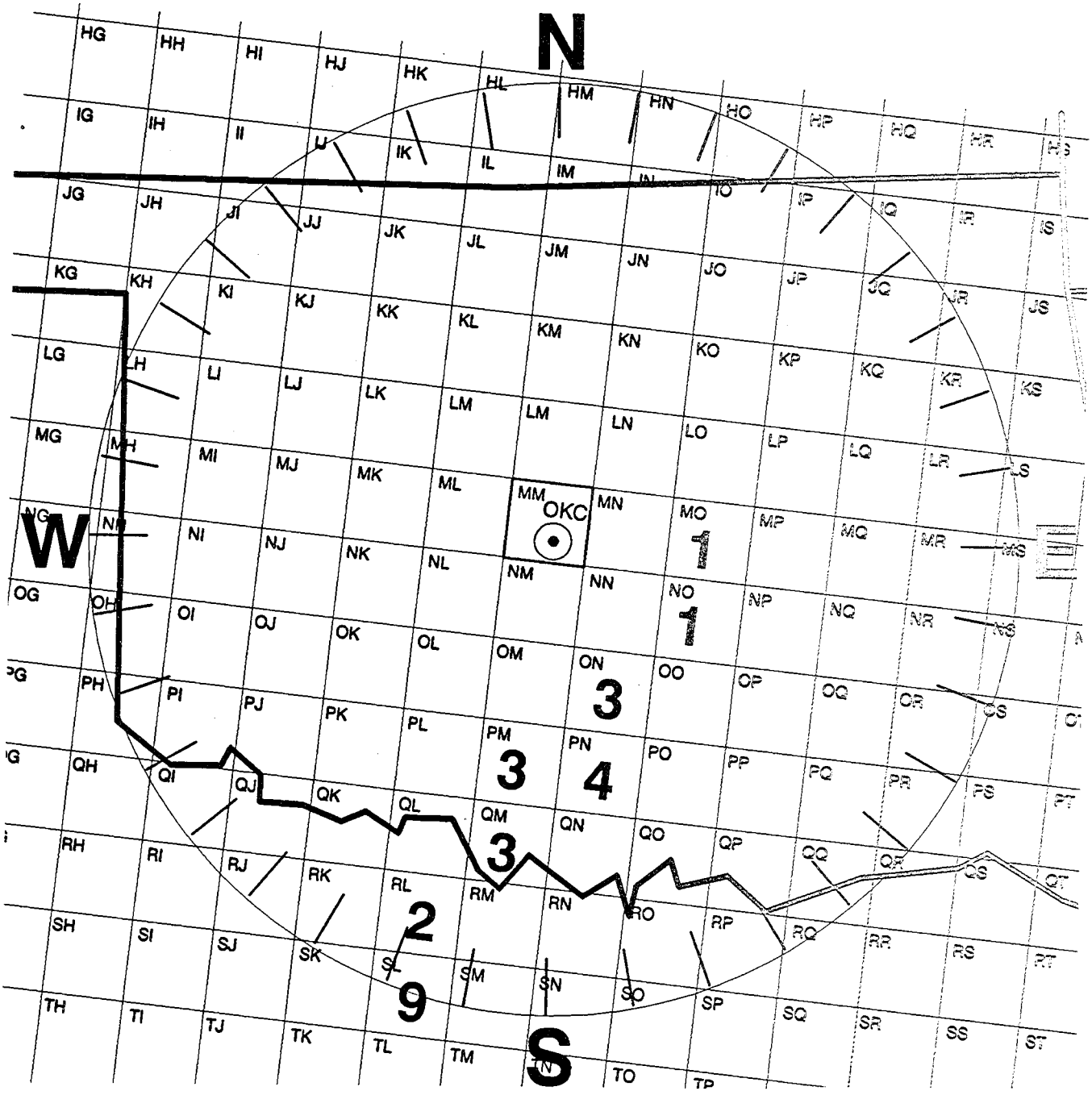


FIGURE 3-3. Digital Radar Report Plotted on a PPI Grid Overlay Chart. Data from Table 3-2.
Note: See Table 7-1 for Intensity Level Codes 1 through 6.
The following VIP LEVEL codes are used for echoes beyond 125 nautical miles:
8 = Echoes of unknown intensity but believed to be severe from other reports.
9 = Echoes of unknown intensity but not believed to be severe.

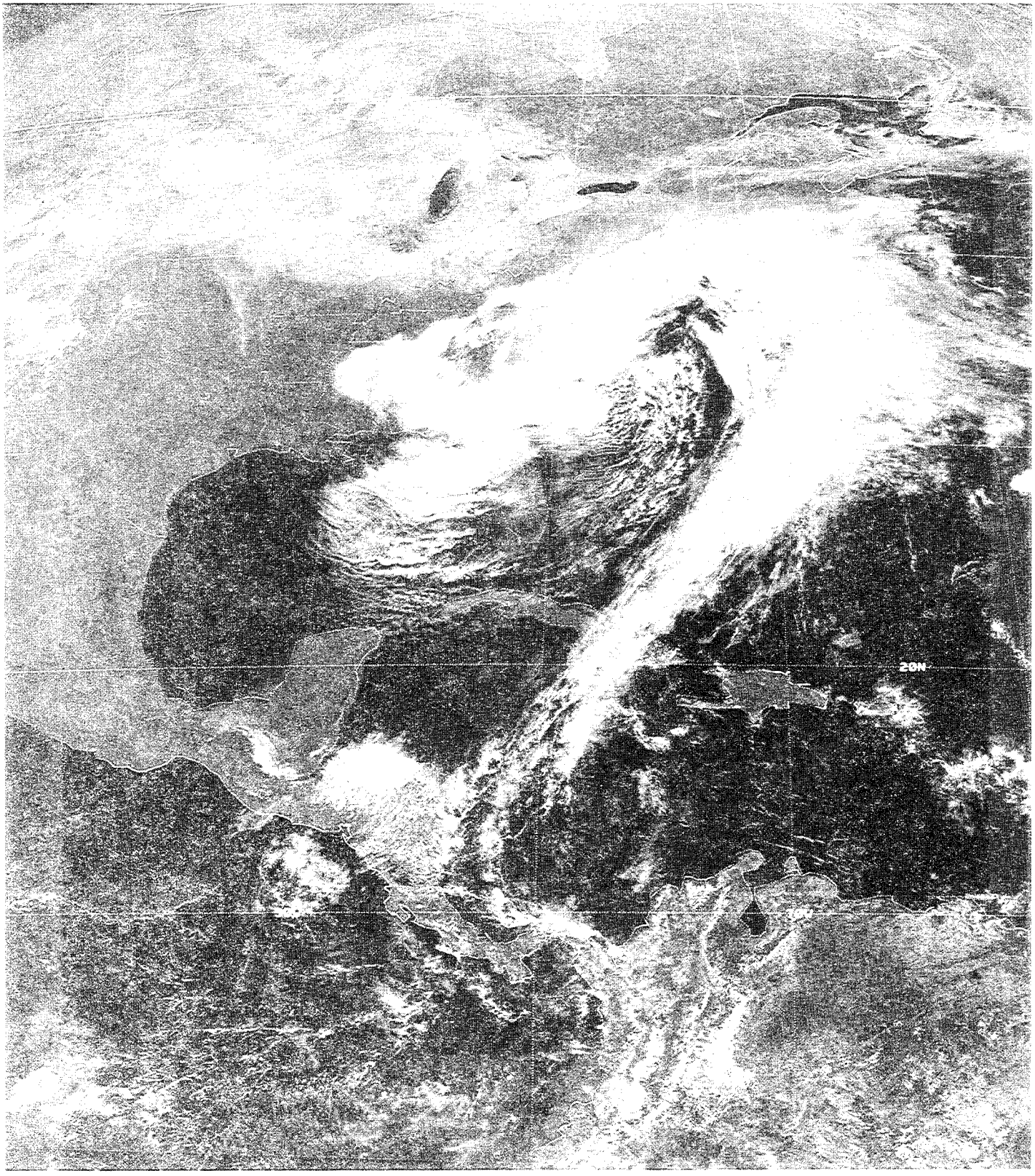


Figure 3-4. Visible Satellite Imagery

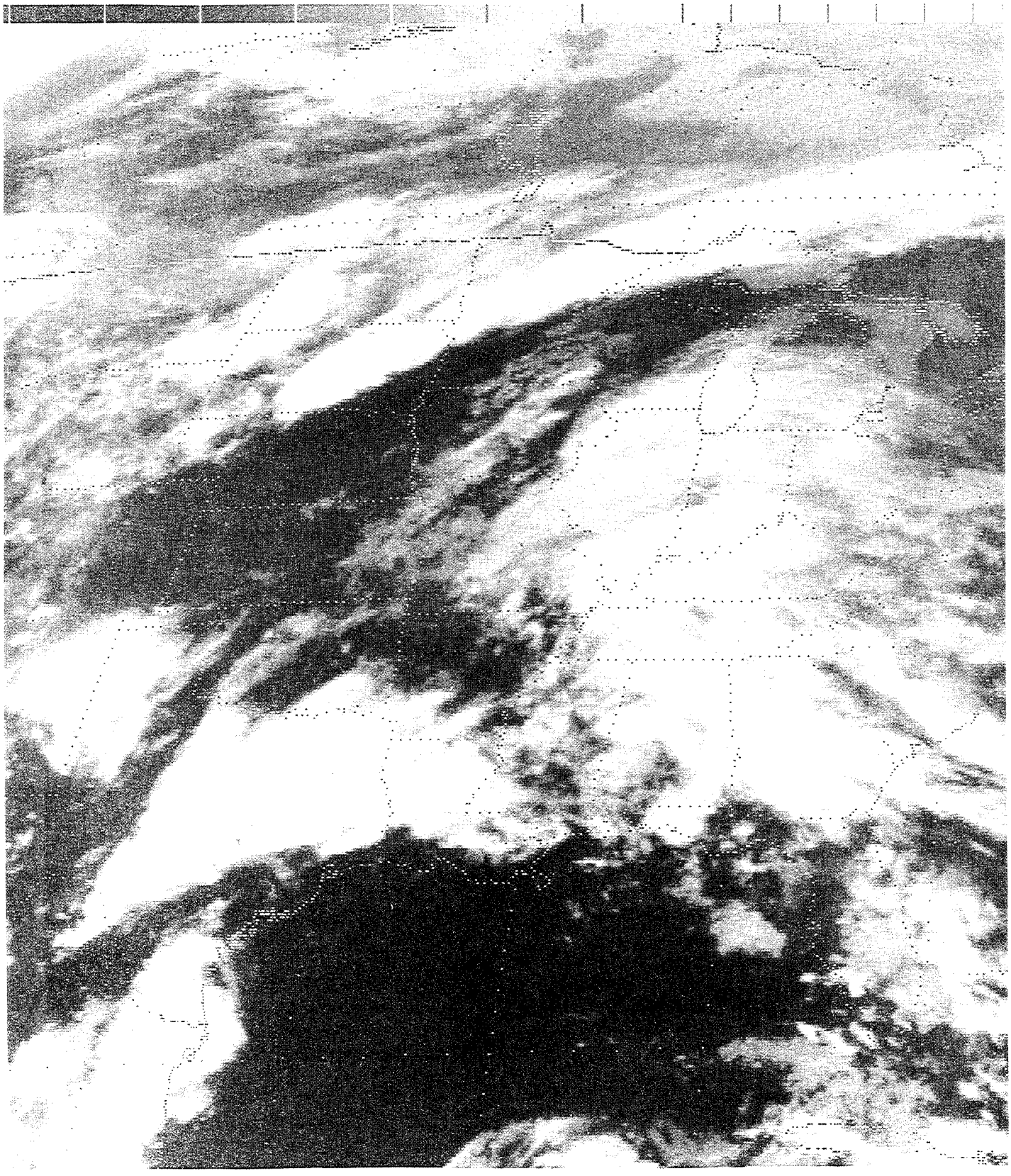


Figure 3-5. Infrared Satellite Imagery

Section 4

AVIATION WEATHER FORECASTS

Note: For information on an important future change in the aviation weather reporting and forecasting system, see the Aviation Routine Weather Report (METAR) on page 2-10 and International Terminal Aerodrome Forecast (TAF) on page 4-3.

Good flight planning involves considering all available weather information, including weather forecasts. This section explains the following aviation forecasts:

1. Terminal Forecasts
   (a). Domestic (FT)
   (b). International (ICAO TAF)
2. Aviation Area Forecast (FA)
3. Convective SIGMET (WST)
4. SIGMET and AIRMET (WS and WA)
5. TWEB Route Forecast and Synopsis
6. Winds and Temperatures Aloft Forecast (FD)
7. Special Flight Forecasts
8. Center Weather Service Unit (CWSU) Products

Also discussed are the following general forecasts which may aid in flight planning:

1. Hurricane Advisory (WH)
2. Convective Outlook (AC)
3. Severe Weather Watch Bulletins (WW) and Alert Messages (AWW)

TERMINAL FORECASTS (FT and TAF)

TERMINAL FORECAST (FT) (Domestic)

A Terminal Forecast (FT) is a description of the weather conditions expected to occur at an airport and within a 5 nautical mile radius of the runway complex. Terminal Forecasts are valid for a 24-hour period. Figures 1-5A through 1-5C depicts the locations where FTs are issued three times daily. Issuance and valid times are according to time zones. Section 15 contains a listing of the issuance and valid times of the FTs. The format of the FT is similar to the SAO (Surface Aviation Observation) report. All times in FTs are Universal Coordinated Time (UTC or Z times).

FT REQUIREMENTS

In order for a forecast to be issued for a terminal, a minimum of two consecutive, complete, routine observations are required from that terminal. This includes terminals with automated weather observations. If for some reason, complete observations are not available from an terminal, the contractions "NO UPDTS AVBL" (no updates available) or "FT NOT AVBL" (FT not available) will appear in the FT to alert users. For those terminals which are routinely open part-time only, the FT for these terminals will include the statement "NO UPDTS AFT (time)Z" or "NO UPDTS TIL (time)Z" [no updates after (time)Z or no updates until (time)Z] where "(time)Z" is the hour the terminal closes for the day [AFT (time)Z] or opens for the day and the two required observations have been received [TIL (time)Z]. If the required observations are not available at the routine FT issuance time, the contraction "FT DLAD" (FT delayed) is sent out for that terminal.

FT FORMAT

FTs are issued in the following format:

iii FT DDTTTT 1st forecast group.
TTZ 2nd forecast group.
TTTTZ 3rd forecast group.
.
.
TTZ Last forecast group..

The "iii" is the station identifier. "DDTTTT" is the date (DD) and valid period (TTTT) of the forecast. "TTZ" or "TTTTZ" indicates a forecast change group. Note that after the first forecast group, each succeeding forecast group is on a separate line and set in from the left margin. This helps in reading the FT. The number of forecast groups will depend on the complexity of the forecast for that terminal. The period "." at the end of each forecast group indicates the end of that particular forecast group. The last forecast group ends with two periods ".." which indicates the end of the FT itself.

FT CONTENTS

FTs contain the following elements...

LOCATION / TYPE / VALID DATE TIME / FORECAST

Note: the "/" above in the following descriptions are for separation purposes in this publication and do not appear in the actual FTs.

The following are descriptions of the above FT elements:

LOCATION

This is the standard U.S. three letter identifier for the terminal the forecast is issued for.

TYPE

The letters "FT" will always appear here. If it is a routine issuance, this is all that will appear. For delayed, corrected, or updated FTs, the appropriate contraction will appear next (see Unscheduled FTs discussion).

VALID DATE TIME

This is a six digit group, the first two digits is the date the valid period begins. The next four digits are the valid period of the forecast. For routine issuances, this is a 24-hour period. For other types of FTs, this may be less than a 24-hour period. If the FT is delayed, corrected, or updated, the issue time will follow the valid date time (see Unscheduled FTs discussion).

FORECAST

The forecast portion of FTs includes:

Sky Condition / Visibility / Weather and/or Obstructions to Visibility / Wind / Remarks

These elements are described below:

Sky Condition - the height of cloud bases are forecast in hundreds of feet above ground level. Cloud amounts are forecast in tenths of sky cover. The contractions for sky cover are:

CLR (clear) - less than 1/10 cover
SCT (scattered) - 1/10 to 5/10's cover
BKN (broken) - 6/10's to 9/10's cover
OVC (overcast) - 1.0 or complete cover.

If a thin cloud layer is expected, it is noted by a "-" between the cloud height and cloud amount. If a ceiling is expected, the ceiling layer will be prefixed with the letter "C". A partially obscured sky is noted by a "-X" prior to the actual sky cover forecast. A totally obscured sky is forecast by an "X" preceded by a "C" to denote this as a ceiling.

Visibility - visibility is forecast in statute miles. If the prevailing visibility is expected to be 6 miles or more, a visibility forecast is not included in the FT.

Weather and/or Obstructions to Visibility - if a weather phenomena or an obstruction to visibility of significance to aviation operations are expected, they will be included as the prevailing conditions in the FT. The following tables contain the weather and obstructions to visibility which may appear in an FT.

TABLE 4-1. FT Weather

R	RAIN	ZR	FREEZING RAIN
S	SNOW	ZL	FREEZING DRIZZLE
RW	RAIN SHOWER	IP	ICE PELLETS
SW	SNOW SHOWER	IC	ICE CRYSTALS
T	THUNDERSTORM	A	HAIL
L	DRIZZLE	IPW	ICE PELLET SHOWERS
SG	SNOW GRAINS	SP	SNOW PELLETS

Precipitation intensities are forecast using the following symbols:

Light	-
Moderate	(no sign)
Heavy	+

A severe thunderstorm is forecast as "T+." A *severe thunderstorm* is one in which the surface wind is 50 knots or greater and/or surface hail is 3/4 inch or more in diameter.

Obstructions to vision include the phenomena listed in Table 4-2. No intensities are reported for obstructions to vision.

TABLE 4-2. FT Obstructions to Visibility

F	FOG	BD	BLOWING DUST
GF	GROUND FOG	BN	BLOWING SAND
H	HAZE	BS	BLOWING SNOW
K	SMOKE	IF	ICE FOG
D	DUST	VOLCANIC ASH	WRITTEN OUT

Wind - the wind is forecast by direction and speed. The direction is forecast in tens of degrees relative to true north. The speed is forecast in knots. Wind gusts are noted by a "G" after the speed followed by the peak gust expected. If a speed of less than 6 knots is expected, a wind forecast is not included in the FT.

Remarks - remarks are added to a forecast group to

amplify or describe expected weather conditions which differ from those forecast as the prevailing conditions.

The remark "LLWS" for low level wind shear is used when a significant change or shear in wind direction or speed is expected within 2000 feet of the surface. If the magnitude and duration of the expected shear is known, it may be included with the LLWS remark.

The conditional remark "OCNL" for occasional is used to describe those conditions which have a high probability (greater than 50%) of occurring, but are expected to last for a period of time less than one-half of the forecast period. Thus if a forecast period is 6 hours long, an occasional condition during that period is expected to last less than 3 hours. The "OCNL" remark is used for differing sky and visibility conditions and for precipitation and thunderstorm events.

The probability remark "CHC" for chance is used only with expected precipitation and thunderstorms events and not within 6 hours of the FT issuance. The probability of occurrence of these events is 30 to 49 percent.

The remark "VCNTY" for vicinity is used to describe dense fog (visibility below 3 miles), showers or thunderstorms that develop, or are expected to develop, beyond the FT's 5 nautical mile radius out to about 25 miles, which may directly affect operations to and from the airport.

Frontal passages are also a form of remarks used in FTs, however they appear immediately after the time in the forecast change group the front is expected to pass the terminal. The contractions for frontal passages are:

CFP - cold frontal passage
WFP - warm frontal passage
OCF - occluded frontal passage

An example of frontal passage in an FT:

OKC FT 112222 C20 BKN 1610 OCNL 20 SCT
01Z CFP 40 SCT 3110 etc...

In this example, a cold front is expected to pass through Oklahoma City around 0100Z with improving conditions behind the front.

SCHEDULED FT COLLECTIVES

FTs are normally issued in a collective by forecast areas. The heading of an FT collective identifies the message as an FT along with a 6-digit date-time group giving the transmission time. For example, "FT130945" means a collective transmitted on the 13th at 0945Z. A collective FT message will usually be broken down into states, i.e. "TX 130945" would be followed by a group of FTs for terminals in the state of Texas.

UNSCHEDULED FTS

Delayed, corrected, or amended FTs are FTs which are issued at times other than the normal issuance times. An unscheduled FT is identified in the message rather than in the heading. The following are examples of a delayed FT for Binghamton, NY, a corrected FT for Memphis, TN, and an amended FT for Lufkin, TX.

BGM FT RTD 131615 1620Z 100 SCT 1810. etc.

MEM FT COR 132222 2230Z 40 SCT 300 SCT
OCNL TRW. etc.

LFK FT AMD 131410 1425Z C8 OVC 4F OVC
OCNL BKN. etc.

Note in each forecast a time group follows the valid period. This time group is the forecast issue time.

A routine delayed FT (RTD) is issued for those terminals not on a 24-hour observing schedule. When the first two complete observations of the day are received, an RTD FT is issued. For example, the BGM delayed forecast was issued at 1620Z and not at the scheduled issuance time of 1445Z. This changes the beginning of the valid forecast period from 1500Z to 1600Z. After this, the FT is issued at the normal times.

A corrected FT (COR) is issued when an FT contains typographical or other errors. For example, the FT for MEM was issued at the normal issuance time of 2145Z. After the FT had gone out, an error in the FT was noted, so a correction was issued at 2230Z. The valid time remains the same as in the original FT.

An amended or updated FT (AMD) is necessary for a situation in which the forecast has to be revised due to significant changes in the weather. For example the original FT issued for LFK at 0945Z was not verifying, so an amended forecast was issued at 1425Z. In this case, the valid period of the amended forecast begins at the hour nearest the issuance time and continues until the end of the valid period of the original FT.

FTS FOR AUTOMATED OBSERVATION LOCATIONS

FTs are issued for automated observations sites when the local NWS Manager feels there is sufficient, reliable information available through augmentation or other means and that representative weather conditions at the site can be determined by the forecasters. This may include non-augmented automated observation sites.

At those sites where the automated observations are augmented on a part-time basis, the statement "UPDTS LIMITED TO CIG AND VSBY (AFT TTZ, or TIL TTZ, or TTZ-TTZ)" will be included with last FT

issued for that site each day. When users see this statement in an FT, they should not expect updates for thunderstorms and/or freezing precipitation for the times shown by the qualifiers AFT (after), TIL (until), or the period from TTZ-TTZ for that terminal. Updates may still be issued for changes in ceilings and visibilities.

Example of an FT:

MEM FT 121818 C30 BKN 5H 2012.
20Z C30 BKN 5H 2012 OCNL C8 OVC 1TRW.
02Z CFP C15 BKN 25 OVC 3315G20 OCNL 3RW.
04Z C8 OVC 3512 CHC 2R-S-.
10Z C12 BKN 0208.
12Z CLR 3F OCNL 1/2F.
16Z CLR..

This is a routine FT for Memphis, TN, issued on the 12th and is valid from 1800Z until 1800Z the next day.
The first forecast group calls for a ceiling of 3,000 feet broken, visibility 5 miles in haze, and a wind from 200 degrees at 12 knots.
The second forecast group includes after 2000Z, an occasional thunderstorm with a ceiling 800 feet overcast and a visibility of 1 mile in moderate rain showers. In this case the forecast period is 6 hours long (20Z until 02Z), but the occasional conditions with the thunderstorms will last less than 3 hours (half of the forecast period).
The third forecast group expects a cold front passage within 30 minutes either side of 02Z bringing in ceilings 1,500 feet broken and 2,500 feet overcast. The wind shifts, coming from 330 degrees at 15 knots with gusts to 20 knots. Occasional periods of moderate rain showers reducing visibility to 3 miles is expected. In this case, the prevailing visibility is expected to be 6 miles or more, so it is not included with the forecast.
The fourth forecast group begins around 0400Z and lowers ceilings to 800 feet overcast. The wind is from 350 degrees at 12 knots and there is a chance (less than 50 percent) of a mixture of light rain and light snow reducing visibilities to 2 miles.
The fifth forecast group begins around 10Z with conditions improving to ceilings 1,200 feet broken and wind from 020 degrees at 8 knots.
The sixth forecast group begins around 12Z with skies going clear, with fog forming, reducing prevailing visibility to 3 miles and occasionally to one half mile. The wind speed is expected to be less than 6 knots so a wind forecast is not included with this forecast group.
The seventh and last forecast group (note the "..'s) expects clear skies until the end of the valid period of the FT (1800Z).

INTERNATIONAL TERMINAL AERODROME FORECAST (TAF)

On July 1, 1993, a new, revised Terminal Aerodrome Forecast (TAF) format and code replaced the existing TAF code. This new code is in effect in most countries. The exceptions are the United States and Canada. These two countries issue Terminal Forecasts for domestic use and TAFs for the military and those airports serving international aviation.
On January 1, 1996 the U.S. and Canada will convert entirely to the new TAF code. After that date, the new code for weather reports (METAR) and TAFs will be used worldwide. The North American code used in the FT (and SAO) will be discontinued. Although the new TAF code is being adopted worldwide, each country is allowed to make modifications or exceptions to the code for use in each particular country. The TAF code, as described here, is the one used in the United States for those airports serving international aviation and will also be used after the January 1, 1996 conversion date. The World Meteorological Organization's (WMO) publication No. 782 "Aerodrome Reports and Forecasts" contains the base METAR and TAF code as adopted by the WMO member countries.
TAFs are forecasts for international flights and use the same code used in the METAR weather reports. See Section 2 for a description of the METAR code. They are scheduled four times daily for 24-hour periods beginning at 0000Z, 0600Z, 1200Z, and 1800Z. See Section 15 for issuance times.
A TAF is a concise statement of the expected meteorological conditions at an airport during a specified period (usually 24 hours). TAFs are issued in the following format:

TYPE / LOCATION / ISSUANCE TIME / VALID TIME / FORECAST

Note: the "/" above and in the following descriptions are for separation purposes in this publication and do not appear in the actual TAFs.

The following is a description of the above elements which make up a TAF.

TYPE

There are two types of TAF issuances, a routine forecast issuance (TAF) and an amended forecast (TAF AMD). An amended TAF is issued when the current TAF no longer adequately describes the on-going weather or the forecaster feels the TAF is not representative of the current or expected weather. Either TAF or TAF AMD appears as a separate product header line before the text of the forecast.

Corrected (COR) or delayed (RTD) TAFs are identified only in the communications header which precedes the actual forecasts.

LOCATION

The TAF code uses ICAO 4-letter location identifiers. In the contiguous 48 states, the 3-letter domestic location identifier is prefixed with a "K"; i.e., the domestic identifier for Seattle is SEA while the ICAO identifier is KSEA. Elsewhere, the first two letters of the ICAO identifier indicate what region of the world and country (or state) the station is in. For Alaska, all station identifiers start with "PA"; for Hawaii, all station identifiers start with "PH". Canadian station identifiers start with "CU", "CW", "CY", and "CZ"; Mexican station identifiers start with "MM". The identifier for the western Caribbean is "M" followed by the individual country's letter; i.e., Cuba is "MU", Dominican Republic "MD", the Bahamas "MY". The identifier for the eastern Caribbean is "T" followed by the individual country's letter; i.e., Puerto Rico is "TJ". For a complete worldwide listing see ICAO Document 7910, "Location Indicators".

ISSUANCE DATE/TIME

This is a 6-digit group giving the date (first two digits) and time (last four digits) in UTC the forecast is issued.

VALID PERIOD

This is a four-digit group which gives the valid period, usually 24 hours, of the forecast in UTC. In the case of an amended forecast, or a forecast which is corrected or delayed, the valid period may be for less than 24 hours. Where an airport or terminal operates on a part time basis (less than 24 hours/day), the TAFs issued for those locations will have the abbreviated statement "AMD NOT SKED AFT (closing time) UTC" added to their forecasts. For the TAFs issued while these locations are closed, the word "NIL" will appear in place of the forecast text. A delayed (RTD) forecast will then be issued for these locations after two complete observations are received.

FORECAST

This is the body of the TAF. The basic format is:

WIND / VISIBILITY / WEATHER / SKY CONDITION

The wind, visibility, and sky condition elements are always included in the initial time group of the forecast. Weather is included only if significant to aviation.

If a significant, lasting change in any of the elements is expected during the valid period, a new time period with the changes is included. It should be noted that the new time period will include only those elements which are expected to change, i.e., if a lowering of the visibility is expected but the wind is expected to remain the same, the new time period reflecting the lower visibility would not include a forecast wind. The forecast wind would remain the same as in the previous time period.

Any temporary conditions expected during a specific time period are included with that time period. The following describes the elements in the above format.

WIND - this five (or six) digit group includes the expected wind direction (first 3 digits) and speed (last 2 digits or 3 digits if 100 knots or greater). The contraction "KT" follows to denote the units of wind speed. Wind gusts are noted by the letter "G" appended to the wind speed followed by the highest expected gust.

A variable wind direction is noted by "VRB" where the three digit direction usually appears. A calm wind (3 knots or less) is forecast as "00000KT".

Examples:
18010KT - wind forecast from 180 degrees at 10 knots.
35012G20KT - wind forecast from 350 degrees at 12 knots with gusts to 20 knots.

VISIBILITY - the expected prevailing visibility up to and including 6 miles is forecast in statute miles, including fractions of miles, followed by "SM" to note the units of measure. Expected visibilities greater than 6 miles are forecast as a Plus 6SM.

Examples:
1/2SM - visibility one-half statute mile
4SM - visibility four statute miles
P6SM - visibility greater than 6 statute miles

WEATHER - weather phenomena significant to aviation are forecast in the following format in TAFs:

Intensity or Proximity / Descriptor / Precipitation / Obstruction to Visibility / Other

Intensity - in the TAF, intensities are noted by a "-" for light, no symbol for moderate, and "+" for heavy. These intensity symbols apply to precipitation only.

Proximity - this applies to weather conditions expected to occur in the vicinity of the airport (between a 5 to 10 statute mile radius of the airport), but not at the airport itself. It is denoted by the letters "VC".

Descriptor - there are seven descriptors which apply to forecast precipitation and/or obstructions to visibility.

TS - thunderstorm	DR - low drifting
SH - shower	MI - shallow
FZ - freezing	BC - patches
BL - blowing	

Precipitation - there are five types of precipitation forecast in TAFs.

RA - rain	GR - hail (> 1/4")
SN - snow	GS - small hail/snow pellets
PE - ice pellets	

Note: for automated observing stations, UP for unknown precipitation type will be forecast.

Obstructions to Visibility - there are eight types of obstructing phenomena forecast in TAFs.

FG - fog (vsby < 5/8 mile)	PY - spray
BR - mist (vsby 5/8 - 6 mi)	SA - sand
FU - smoke	DU - dust
HZ - haze	VA - volcanic ash

Note: Fog (FG) is forecast only when the visibility is expected to be less than five-eighths of mile, otherwise mist (BR) is forecast.

Other - there are five other weather phenomena which are included in TAFS.

SQ - squall	SS - sandstorm
DS - duststorm	PO - dust/sand whirls
FC - funnel cloud/tornado/waterspout	

Examples of forecast weather:
+TSRA - thunderstorm with heavy rain
SNRA - snow and rain mixed
RA FG - rain and fog (note the space)
FUHZ - smoke and haze
FZRA - freezing rain

If no significant weather is expected to occur during a specific time period in the forecast, the weather group is omitted for that time period. If, after a time period in which significant weather is forecast, a change to a forecast of no significant weather occurs, the contraction NSW (No Significant Weather) will appear as the weather group in the new time period.

SKY CONDITION - sky condition is forecast in TAFs in the following format:

Amount / Height / (Type) or Vertical Visibility

Amount - the expected amount of sky cover is forecast in eighths of sky cover, using the contractions:

SKC - clear (no clouds or less than 1/8 clouds)
SCT - scattered (1/8 to 4/8s of clouds)
BKN - broken (5/8s to 7/8s of clouds)
OVC - overcast (sky totally covered)

Note: Ceiling layers are not designated in the TAF code. For aviation purposes, the ceiling is the lowest broken or overcast layer or vertical visibility into an obscuration.

Height - the bases of expected clouds layers are forecast with three digits in hundreds of feet.

Examples:
SCT008 BKN020 OVC100 - scattered clouds at 800 feet, broken clouds at 2,000 feet, overcast clouds at 10,000 feet.
SKC - clear, no clouds

(Type) - if cumulonimbus clouds are expected at the airport, the contraction "CB" is appended to the cloud layer which represents the base of the cumulonimbus cloud(s). Cumulonimbus clouds are the only cloud type forecast in TAFs.

Example:
SCT050 BKN025CB BKN250 - scattered clouds at 500 feet, broken cumulonimbus cloud(s) at 2,500 feet, broken clouds at 25,000 feet.

Vertical Visibility - when the sky is totally obscured, vertical visibility into the obscuration is forecast in the format "VVhhh" where VV denotes vertical visibility and "hhh" is the expected vertical visibility in hundred's of feet. There is no provision in the TAF code to forecast partial obscurations.

Example:
1/2SM FG VV012 - vertical visibility 1,200 feet (with horizontal visibility one half mile in fog).

PROBABILITY FORECAST

A PROB40 (PROBability) HHhh group in a TAF indicates the probability of occurrence of thunderstorms or other precipitation events. The PROB group is used when the occurrence of thunderstorms or precipitation is in the 30% to less than 50% range, thus the probability value 40 is appended to the PROB contraction. This is followed by a four digit group giving the beginning time (HH) and ending time (hh) of the time period during which the thunderstorms or precipitation is expected. Following this will be the

conditions expected with the thunderstorms and/or precipitation.

Examples:

PROB40 2102 1/2SM +TSRA OVC005CB - between the hours of 2100Z and 0200Z, there is a 40 percent probability of conditions of five hundred feet overcast in a cumulonimbus cloud, visibility one half mile in a thunderstorm with heavy rain.

PROB40 1014 1SM RASN - between the hours of 1000Z and 1400Z, a chance (40%) of rain and snow mixed reducing visibility to one mile is expected.

TEMPORARY CONDITIONS

When temporary conditions are expected to occur during the forecast valid period, a TEMPO (TEMPOrary) HHhh group indicates this.

The TEMPO group is used for any conditions in wind, visibility, weather, or sky condition which are expected to last for generally less than an hour at a time. The time period during which the temporary conditions are expected are given by a four-digit group giving the beginning time (HH) and ending time (hh) of the time period following the TEMPO indicator.

Examples:

SCT030 TEMPO 1923 BKN030 - predominant sky condition is scattered clouds at 3,000 feet, but between the hours of 1900Z and 2300Z, broken clouds at 3,000 feet will exist for periods of less than one hour.

4SM HZ TEMPO 1215 2SM BRHZ - prevailing visibility is 4 miles in haze, but between the hours of 1200Z and 1500Z, visibility of 2 miles in mist (fog) and haze is expected for periods of less than one hour.

FORECAST CHANGE GROUPS

A significant, permanent change in existing conditions during the valid period of the TAF is indicated by the change groups FMHH (FroM) and BECMG (BECoMinG) HHhh.

The FMHH change group is used when a rapid change, usually less than one hour, in conditions is expected. The hour (HH) the change is expected is appended to the FM indicator.

Example:

...BKN030 FM01 SKC...

Prior to 0100Z the sky condition is broken clouds at 3,000 feet. Around 0100Z, the sky condition will change to clear and will continue until the next change group or until the end of the current forecast.

The BECMG HHhh change group is used when a gradual change in conditions is expected over a longer time period, usually two hours. The times the change is expected is a four-digit group with the beginning (HH) and ending times (hh) of the change period which follows the BECMG indicator.

Example:

...3SM BR OVC012 BECMG 1416 5SM HZ BKN020...

Prior to 1400Z the visibility is 3 miles in mist and the sky condition is overcast clouds at 1,200 feet. During the hours from 1400Z to 1600Z, a gradual change to visibility of 5 miles in haze and broken clouds at 2,000 feet is expected and will continue until the next change group or the next forecast.

See the top of page 4-8 for an example of a TAF and how to decode it.

AVIATION AREA FORECAST (FA)

An aviation Area Forecast (FA) is a forecast of general weather conditions over an area the size of several states. It is used to determine forecast en route weather and to interpolate conditions at airports which do not have FTs issued. Figure 1-4 maps the FA areas. FAs are issued 3 times a day by the National Aviation Weather Advisory Unit (NAWAU) in Kansas City, MO, for each of the 6 areas in the contiguous 48 states. In Alaska, FAs are issued by the WSFOs in Anchorage, Fairbanks, and Juneau for their respective area (Figure 1-4A) and utilized a different format (see "Alaska Area Forecasts"). The WSFO in Honolulu issues FAs for Hawaii (Figure 1-4A). A specialized FA for the Gulf of Mexico is issued by the National Hurricane Center in Miami, FL. This product combines both aviation and marine information and is intended to support offshore helicopter operations. The Gulf of Mexico FA focuses on an area which includes the coastal plains and coastal waters from Apalachicola, FL to Brownsville, TX, and the offshore waters of the Gulf of Mexico, in an area west of 85W and north of 27N.

An example of an Aviation Area Forecast (FA):

SLCC FA 141045
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 150500
CLDS/WX VALID UNTIL 142300...OTLK VALID 142300-150500
ID MT NV UT WY CO AZ NM
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TSTMS IMPLY PSBL SVR OR GTR TURBC SVR ICG LLWS AND IFR CONDS.

Example of TAF with decoding by heading and time groups:

TAF
KMEM 121720Z 1818 20012KT 5SM HZ BKN030 PROB40 2022 1SM TSRA OVC008CB FM22 33015G20KT P6SM BKN015 OVC025 PROB40 2202 3SM SHRA FM02 35012KT OVC008 PROB40 0205 2SM -RASN BECMG 0608 02008KT NSW BKN012 BECMG 1012 00000KT 3SM BR SKC TEMPO 1214 1/2SM FG FM16 VRB04KT P6SM NSW SKC.

TAF KMEM 121720Z 1818 - TAF issued for Memphis, TN on the 12th at 1720Z and valid for a 24 hour period from 1800Z to 1800Z.

20012KT 5SM HZ BKN030 PROB40 2022 1SM TSRA OVCOO8CB - forecast for the hours from 1800Z to 2200Z (beginning of next time period), wind from 200 degrees at 12 knots, visibility 5 statute miles in haze, broken clouds at 3,000 feet. A chance (40%) of thunderstorm with moderate rain, visibility 1 statute mile, and overcast sky at 800 feet by cumulonimbus cloud.

FM22 33015G20KT P6SM BKN015 OVC025 PROB40 2202 3SM SHRA - forecast for the hours from 2200Z to 0200Z, wind from 330 degrees at 15 knots with gusts to 20 knots, visibility greater than 6 statute miles, broken clouds at 1,500 feet, overcast clouds at 2,500 feet. Between the hours of 2200Z and 0200Z, a chance (40%) of visibility 3 statute miles in moderate rain showers.

FM02 35012KT OVC008 PROB40 0205 2SM -RASN - forecast for the hours from 0200Z to 0600Z, wind from 350 degrees at 12 knots, overcast clouds at 800 feet. Between the hours of 0200Z and 0500Z, a chance (40%) of visibility 2 statute miles in light rain and snow mixed. Note: the prevailing visibility is not expected to change from P6SM forecast in the previous time period, so a visibility forecast is not included after the wind forecast.

BECMG 0608 02008KT NSW BKN012 - between 0600Z and 0800Z conditions forecast to become wind from 020 degrees at 8 knots, no significant weather, broken clouds at 1,200 feet with conditions continuing until 1000Z.

BECMG 1012 00000KT 3SM BR SKC TEMPO 1214 1/2SM FG - between 1000Z and 1200Z conditions forecast to become wind calm, visibility 3 statute miles in mist, with clear skies. Between the hours of 1200Z and 1400Z visibility temporarily 1/2 statute mile in fog. Conditions continuing until 1600Z.

FM16 VRB04KT P6SM NSW SKC - from 1600Z until the end of the forecast (1800Z), wind variable in direction at 4 knots, visibility greater than 6 statute miles, no significant weather, and sky clear.

NON MSL HGTS ARE DENOTED BY AGL OR CIG.

SYNOPSIS...HIGH PRES OVER NERN MT CONTG EWD GRDLY. LOW PRES OVR AZ NM AND WRN TX RMNG GENLY STNRY. ALF...TROF EXTDS FROM WRN MT INTO SRN AZ RMNG STNRY..

.
ID MT
FROM YXH TO SHR TO 30SE BZN TO 60SE PIH TO LKT TO YXC TO YXH.
70-90 SCT-BKN 120-150. WDLY SCT RW-. TOPS SHWRS 180.
OTLK...VFR
RMNDR AREA...100-120. ISOLD RW- MNLY ERN PTNS AREA.
OTLK...VFR.

.
UT NV NM AZ
80 SCT-BKN 150-200. WDLY SCT RW-/TRW-. CB TOPS 450.
OTLK...VFR.

.
WY CO
FROM BZN TO GCC TO LBL TO DVC TO RKS TO BZN.
70-90 BKN-OVC 200. OCNL VSBY 3R-F. AFT 20Z WDLY SCT TRW-. CB TOPS 450. OTLK...MVFR CIG RW.

The FA is comprised of four sections: a communications and product header section, a precautionary statement section, and two weather sections; a SYNOPSIS section and a VFR CLOUDS/WX section.

COMMUNICATIONS AND PRODUCT HEADERS

The communications and product header identify the office for which the FA is issued, the date and time of issue, the product name, the valid times, and the states and/or areas covered by the FA. The following shows the communications and product headers for the example FA. It was issued for the Salt Lake City area (the "C" after SLC identifies the product containing a Clouds and Weather forecast) on the 14th at 1045Z. The next line is the plain language product name. The third line is the valid period of the SYNOPSIS and the fourth line is the valid periods of the CLOUDS/WX and OTLK sections. The beginning of the valid period is the hour after the forecast is issued, in this case 1100Z. The last line lists the states that make up the Salt Lake City forecast area.

SLCC FA 141045
SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 150500
CLDS/WX VALID UNTIL 142300...OTLK VALID 142300-150500
ID MT NV UT WY CO AZ NM

PRECAUTIONARY STATEMENTS

Between the communications/products headers and the body of the forecast are three precautionary statements which are in all Area Forecasts. The first statement,

SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSC

is included to alert users that IFR conditions and/or mountain obscurations may be occurring or may be

forecast to occur in a portion of the FA area. The user should always check the latest AIRMET Sierra for the FA area.

The second statement,

TSTMS IMPLY PSBL SVR OR GTR TURBC SVR ICG LLWS AND IFR CONDS

is included as a reminder of the hazards existing in all thunderstorms. Thus, these thunderstorm associated hazards are not spelled out within the body of the FA.

NON MSL HGTS ARE DENOTED BY AGL OR CIG

The purpose of this statement is to alert the user that heights, for the most part, are *above sea level.* All heights are in hundreds of feet. For example, 30 BKN 100 HYR TRRN OBSCD means bases of the broken clouds are 3,000 feet MSL with tops 10,000 feet MSL. Terrain above 3,000 feet MSL will be obscured. The tops of the clouds, turbulence, icing and freezing level heights are always MSL.

Heights *above ground level* are noted in either of two ways:

(1) Ceilings by definition are above ground. Therefore, the contraction "CIG" indicates above ground. For example, "CIGS GENLY BLO 10" means that ceilings are expected to be generally below 1,000 feet above ground level.

(2) The contraction "AGL" means above ground level. Therefore, "AGL 20 SCT" means scattered clouds with bases 2,000 feet above ground level.

Thus, if the contraction "AGL" or "CIG" is not denoted, height is automatically above MSL.

SYNOPSIS

The SYNOPSIS is a brief summary of the location and movements of fronts, pressure systems, and circulation patterns for an 18-hour period. References to low ceilings and/or visibilities, strong winds or any other phenomena the forecaster considers useful may also be included.

For example:

SYNOPSIS...HIGH PRES OVER NERN MT CONTG EWD GRDLY. LOW PRES OVR AZ NM AND WRN TX RMNG GENLY STNRY. ALF...TROF EXTDS FROM WRN MT INTO SRN AZ RMNG STNRY.

This paragraph states that high pressure over northeastern Montana will continue to move gradually eastward. Low pressure over Arizona, New Mexico and western Texas will remain stationary. Aloft, a low pressure trough extending from western Montana into southern Arizona will remain stationary.

VFR CLOUDS AND WEATHER (VFR CLDS/WX)

Hazardous weather, i.e., IFR, icing, and turbulence conditions, are not included in the Area Forecast, but are included in the In-Flight Aviation Weather Advisories (see page 4-10).

This section contains a 12-hour specific forecast, followed by a 6-hour (18 hour in Alaska) categorical outlook giving a total forecast period of 18 hours (30 hours in Alaska).

The VFR CLDS/WX section is usually several paragraphs long. The breakdown may be by states or by well-known geographical areas. The specific forecast section gives a general description of clouds and weather which cover an area greater than 3,000 square miles and is significant to VFR flight operations.

Surface visibility and obstructions to vision are included when the forecast visibility is six statute miles or less. Precipitation, thunderstorms, and sustained winds of 20 knots or greater are always included when forecast. The conditional term OCNL (occasional) is used to describe clouds and visibilities which may affect VFR flights. Table 4-3 defines the conditional term. The areal coverage terms ISOLD (isolated), WDLY SCT (widely scattered), SCT or AREAS (scattered), and NMRS or WDSPRD (numerous or widespread) are used to indicate the area coverage of thunderstorms or showers. The term ISOLD may also be used to describe areas of ceilings or visibilities which are expected to affect areas less than 3,000 square miles. Table 4-4 defines the areal coverage terms.

TABLE 4-3. Conditional Term Definition

Term	Description
OCNL	A greater than 50% probability of a phenomena occuring but for less than 1/2 of the forecast period

TABLE 4-4. Area coverage of showers and thunderstorms

Adjective	Coverage
Isolated	Single cells (no percentage)
Widely scattered	Less than 25% of area affected
Scattered or Areas	25 to 54% of area affected
Numerous or Widespread	55% or more of area affected

For example, from the Area Forecast on page 8:

WY CO
FROM BZN TO GCC TO LBL TO DVC TO RKS TO BZN.
70-90 BKN-OVC 200. OCNL VSBY 3R-F. AFT 20Z WDLY SCT TRW-. CB TOPS 450. OTLK..MVFR CIG RW.

This part of the VFR CLDS/WX section is the forecast for the states of Wyoming and Colorado. The exact area coverage of the forecast is from Bozeman, MT, to Gillette, WY, to Liberal, KS, to Dove Creek, WY, to Rock Springs, WY, and back to Bozeman, MT. The specific forecast period is from the 14th day of the month at 1100Z to 2300Z. The base of the broken to overcast layer of clouds is 7,000 to 9,000 feet MSL with the tops of the clouds at 20,000 feet MSL. The visibility is expected to be greater than six statute miles and winds less than 20 knots, both by omission. The visibility is forecast to occasionally (Table 4-3) be 3 statute miles in light rain and fog. After 2000Z, widely scattered thunderstorms (Table 4-4) are expected with tops to 45,000 feet MSL. The outlook for this same area from 1100Z until 0500Z the next day is for marginal VFR conditions due to ceilings and rain showers.

A categorical outlook, identified by "OTLK" is included for each area breakdown. A categorical outlook of IFR and MVFR can be due to ceilings only (CIG), restriction to visibility only (TRW, F, etc), or a combination both (CIG, TRW, F, etc).

For example,

OTLK..VFR BCMG MVFR CIG F AFT 09Z.

means the weather is expected to be VFR, becoming MVFR due to low ceiling and visibilities restricted by fog after 0900Z. "WND" is included in the outlook if winds, sustained or gusty, are expected to be 20 knots or greater. For criteria of each category, refer to the legend on the weather depiction chart (Section 6).

AMENDED AVIATION AREA FORECASTS

Amendments to the FA are issued as needed. Only that section of the FA being revised is transmitted as an amendment. Area Forecasts are also amended and updated by Inflight Advisories (AIRMETs, SIGMETs, and Convective SIGMETs). An amended FA is identified by "AMD," a corrected FA is identified by "COR", and a delayed FA is identified by "RTD."

IN-FLIGHT AVIATION WEATHER ADVISORIES (WST, WS, WA)

In-flight Aviation Weather Advisories are forecasts to advise en route aircraft of development of potentially hazardous weather. All In-flight Advisories in the conterminous U.S. are issued by the National Aviation Weather Advisory Unit (NAWAU) in Kansas City, MO. In Alaska, the three WSFOs (Anchorage, Fairbanks and Juneau) issue In-flight Advisories for their respective areas. The WSFO in Honolulu issues advisories for Hawaii. All heights are referenced to MSL, except in the case of ceilings (CIG) which indicates above ground level. The advisories are of three types - Convective SIGMET (WST), SIGMET (WS) and AIRMET (WA). All In-flight Advisories use the same location identifiers (either VORs, airports, or well-known geographic areas) to describe the hazardous weather areas (Figures 4-1 and 4-2).

CONVECTIVE SIGMET (WST)

Convective SIGMETs are issued in the conterminous U.S. for any of the following:

1. Severe thunderstorm due to:
   a. surface winds greater than or equal to 50 knots
   b. hail at the surface greater than or equal 3/4 inches in diameter
   c. tornadoes.
2. Embedded thunderstorms.
3. A line of thunderstorms.
4. Thunderstorms greater than or equal to VIP level 4 affecting 40% or more of an area at least 3000 square miles.

Any Convective SIGMET implies severe or greater turbulence, severe icing and low level wind shear. A Convective SIGMET may be issued for any convective situation which the forecaster feels is hazardous to all categories of aircraft.

Convective SIGMET bulletins are issued for the Eastern (E), Central (C) and Western (W) United States (Convective SIGMETs are not issued for Alaska or Hawaii). The areas are separated at 87 and 107 degrees west longitude with sufficient overlap to cover most cases when the phenomenon crosses the boundaries. Thus, a bulletin will usually be issued only for the area where the bulk of observations and forecast conditions are located. Bulletins are issued hourly at H+55. Special bulletins are issued at any time as required and updated at H+55. If no criteria meeting a Convective SIGMET are observed or forecast, the message "CONVECTIVE SIGMET...NONE" will be issued for each area at H+55. Individual Convective SIGMETs for each area are numbered sequentially (01 - 99) each day, beginning at 00Z. A continuing Convective SIGMET phenomenon will be reissued every hour at H+55 with a new number. The text of the bulletin consists of either an observation and a forecast or just a forecast. The forecast is valid for up to 2 hours.

The following are examples of Convective SIGMET bulletins for the Central United States. For the Western United States, they would be numbered 20W and 21W. For the Eastern United States, they would be numbered 20E and 21E.

MKCC WST 221855
CONVECTIVE SIGMET 20C
VALID UNTIL 2055Z
ND SD
FROM 90W MOT-GFK-ABR-90 MOT
INTSFYG AREA SVR TSTMS MOVG FROM 2445. TOP ABV 450. WIND GUSTS TO 60 KTS RPRTD. TORNADOES...HAIL TO 2 IN...WIND GUSTS TO 65 KTS PSBL ND PTN.

CONVECTIVE SIGMET 21C
VALID UNTIL 2055Z
50SE CDS
ISOLD SVR TSTM D30 MOVG FROM 2420. TOPS ABV 450. HAIL TO 2 IN...WIND GUSTS TO 65 KTS PSBL.
OUTLOOK VALID 222055-230055

AREA 1...FROM INL-MSP-ABR-MOT-INL
SVR TSTMS CONT TO DVLP IN AREA OVR ND. AREA IS XPCD TO RMN SVR AND SPRD INTO MN AS STG PVA MOVS OVR VRY UNSTBL AMS CHARACTERIZED BY -12 LIFTED INDEX.
AREA 2...FROM CDS-DFW-LRD-ELP-CDS
ISOLD STG TSTMS WILL DVLP OVR SWRN AND WRN TX THRUT FCST PD AS UPR LVL TROF MOVS NEWD OVR VERY UNSTBL AMS. LIFTED INDEX RMS IN THE -8 TO -10 RANGE. DRY LINE WL BE THE FOCUS OF TSTM DVLPMT.

This is an example of a complete WST bulletin, including the Convective SIGMET Outlook. This is the 20th and 21st Convective SIGMETs of the day in the Central United States. The first message indicates an area of severe thunderstorms in North and South Dakota. These storms have produced wind gusts to 60 knots with the possibility of tornadoes, hail up to 2 inches, and 65 knot winds over North Dakota. The second message is about a single severe thunderstorm southeast of Childress. The outlook section focuses on the Dakotas in Area 1 and Texas in Area 2.

SIGMET (WS) / AIRMET (WA)

SIGMETs / AIRMETs are issued for the six areas corresponding to the FA areas (Figure 1-4). The maximum forecast period is four hours for SIGMETs and six hours for AIRMETs. Both advisories are considered "widespread" because they must be either affecting or be forecast to affect an area of at least 3,000 square miles at any one time. At times, the total area to be affected during the forecast period (see Fig. 4-1; In-flight Advisory Plotting Chart) is very large. It could be that only a small portion of this total area would be affected at any one time. An example would be a 3,000 square mile phenomenon forecast to move across an area totaling 25,000 square miles during a forecast period.

SIGMET (WS)

A SIGMET advises of non-convective weather that is potentially hazardous to all aircraft. In the conterminous U.S., SIGMETs are issued when the following phenomena occur or are expected to occur:

1. Severe icing not associated with thunderstorms
2. Severe or extreme turbulence or clear air turbulence (CAT) not associated with thunderstorms
3. Duststorms, sandstorms, or volcanic ash lowering surface or in-flight visibilities to below three miles
4. Volcanic eruption

SIGMETs are identified by an alphabetic designator which include NOVEMBER through YANKEE but exclude SIERRA and TANGO. The first issuance of a SIGMET will be labeled UWS (Urgent Weather Sigmet) and subsequent issuances at the forecasters discretion. Issuances for the same phenomenon will be sequentially numbered, using the original designator until the phenomenon ends. For example, the first issuance in the CHI area for phenomenon moving from the SLC area will be SIGMET PAPA 3, if the previous two issuances, PAPA 1 and PAPA 2 had been in the SLC area. Note that no two different phenomena across the country can have the same alphabetic designator at the same time.
For example,

DFWP UWS 051710
SIGMET PAPA 1 VALID UNTIL 052110
AR LA MS
FROM STL TO 30N MEI TO BTR TO MLU TO STL
OCNL SVR ICING 90 TO 130 EXPCD.
FRZLVL 80 E TO 120 W. CONDS CONTG BYD 2100Z.

SFOR WS 100130
SIGMET ROMEO 2 VALID UNTIL 100530
OR WA
FROM SEA TO PDT TO EUG TO SEA
OCNL MOGR CAT BTN 280 AND 350 EXPCD DUE TO JTSTR. CONDS BGNG AFT 0200Z CONTG BYD 0530Z AND SPRDG OVR CNTRL ID BY 0400Z.

The first example above is a SIGMET bulletin issued for the DFW area at 1710Z on the 5th and is valid until 2110Z (Note maximum forecast period for a Sigmet is 4 hours). The designator PAPA identifies the phenomenon, in this case, severe icing. This is the first issuance of the SIGMET as indicated by "UWS" and "PAPA 1". The affected states *within* the DFW area are Arkansas, Louisiana and Mississippi. Freezing level data and a notation that conditions are expected to continue beyond 4 hours are included.(See Table 4-9 for definitions of variability terms.)
Some NWS offices have been designated by the International Civil Aviation Organization (ICAO) as Meteorological Watch Offices (MWOs). These offices

are responsible for issuing International SIGMETs for designated areas which include Alaska, Hawaii, portions of the Atlantic and Pacific Oceans, and the Gulf of Mexico. The offices which issue International SIGMETs are Anchorage, AK; Fairbanks, AK; Juneau, AK; Miami, FL; Honolulu, HI; Kansas City, MO; and Guam. The criteria for an International SIGMET are the same as for a domestic SIGMET with the following items added:

1. Thunderstorms occurring in lines or embedded in clouds or haze
2. Tropical cyclones
3. Marked mountain waves
4. Heavy hail
5. Severe squall line

Example of an International SIGMET:

WSAC1 PAFA 080255
PAZA SIGMET JULIETT 1 VALID 080300/080700 PAFA-
MOD OR GREATER TURBC AND ASSOCIATED MTW EFFECT FCST BLW FL350 60 NM EITHER SIDE OF A LINE FM PAOR TO PAFA TO PAMC. NC.

This is SIGMET JULIETT 1 issued by MWO Fairbanks, Alaska (PAFA) at 0255Z on the 8th. Is valid from 0300Z to 0700Z on the 8th and was issued for moderate or greater turbulence and associated mountain wave effect forecast below flight level 35,000 feet for an area 60 nautical miles either side of a line from Northway, Alaska (PAOR) to McGrath, Alaska (PAMC). No change (NC) is expected in the condition during the valid period.

AIRMET (WA)

AIRMETs (WA) are advisories of significant weather phenomena but describe conditions at intensities lower than those which trigger SIGMETs. AIRMETs are intended for dissemination to all pilots in the preflight and en route phase of flight to enhance safety. AIRMET Bulletins are issued on a scheduled basis every 6 hours. Unscheduled updates and corrections are issued as necessary. Each AIRMET Bulletin contains any current AIRMETs in effect, significant conditions not meeting AIRMET criteria, and an outlook for conditions expected after AIRMET valid period. The AIRMETs within each Bulletin are valid for 6 hours and contain details on one or more of the following phenomena when they occur or are forecast to occur:

1. Moderate icing
2. Moderate turbulence
3. Sustained surface winds of 30 knots or more
4. Ceiling less than 1,000 feet and/or visibility less than 3 miles affecting over 50 percent of the area at one time
5. Extensive mountain obscurement

AIRMET Bulletins have fixed alphanumeric designators of SIERRA for Instrument Flight Rules (IFR) and mountain obscurations; TANGO for turbulence, strong surface winds, and low-level wind shear; and ZULU for icing and freezing level. In addition AIRMET SIERRA is referenced in the Area Forecast (FA). After the first issuance each day, scheduled or unscheduled Bulletins are numbered sequentially for easier identification. Example of an AIRMET Bulletin:

ZCZC MKCWA4T ALL 242000
WAUS1 KDFW 241650
DFWT WA 241650 AMD
AIRMET TANGO UPDT 3 FOR TURBC...STG SFC WINDS AND LLWS VALID UNTIL 242000
.
AIRMET TURBC...OK TX...UPDT
FROM OSW TO LRD TO PEQ TO 40W LBL TO OSW
OCNL MDT TURBC BLO 60 DUE TO STG AND GUSTY LOW LVL WINDS. CONDS CONTG BYD 2000Z.
.
AIRMET STG SFC WINDS...TX
FROM CDS TO DFW TO SAT TO MAF TO CDS
AFT 18Z...SUSTAINED SFC WINDS GTR THAN 30 KTS XPCD. COND CONTG BYD 2000Z.
.
LLWS BLO 20 AGL DUE TO STG WINDS DMSHG BY 18Z.
.
OTLK VALID 2000-0200Z...OK TX AR
MDT TURBC BLO 60 CONTG OVR OK/TX AND SPRDG INTO AR BY 2200-0200Z. CONTG ENTR AREA BYD 0200Z.
....
NNNN

ALASKA AREA FORECASTS

The Area Forecasts issued by the NWS offices in Alaska follow a specialized format. The Alaska FA has a SYNOPSIS section similar to the FAs for the 48 contiguous states and Hawaii. Beyond this, the primary difference is that the forecasts and advisories for each individual geographic area are combined into a single product; i.e., each section includes all AIRMETs, SIGMETs, IFR/VFR/MVFR CLOUDS AND WEATHER, designated PASS forecasts where appropriate, ICING, TURBULENCE, STRONG SURFACE WINDS, or any other weather phenomena the forecaster deems important for aviation users for that particular area.

An example of portions of an Anchorage, Alaska, Area Forecast:

/D ANCH FA 211945
AK SRN HLF XCP SE AK...

SYNOPSIS VALID UNTIL 221400
RDG OF HI PRES FM OME TO UAK. OCFNT 120 NM N OF ADK TO DUT AND SEWD MOVG TO SNP TO PTH AND SEWD BY 14Z.

AIRMETS VALID UNTIL 220200
TSTMS IMPLY SVR OR GTR TURBC SRV ICG LLWS AND IFR CONDS. NON MSL HGTS DENOTED BY AGL OR CIG.
.
COOK INLET AND SUSITNA VLY AB...VALID UNTIL 220800
...CLDS/WX...
25 SCT-BKN 65 BKN LYRS TO 90. SCT RW-. LCL CIG AOB 10 AND VSBYS AOB 3RW-.
OTLK VALID 220800-230200... VFR.
PASSES...LK CLARK...MERRILL AND RAINY... MVFR CIG. WINDY AND TAHNETA... VFR. PORTAGE... IFR CIG F.
...TURBC...
NONE SGFNT.
...ICG AND FRZLVL...
NONE SGFNT. FRZLVL 070-080.

.../////...

AK PEN...VALID UNTIL 220800
...CLDS/WX...
AIRMET IFRWDSPRD CIG BLO 10 AND VSBYS BLO 3R-F ALG PAC CST. CONTG BYD 02Z...
AIRMET STG SFC WNDSLCL SFC WNDS SELY 50 KTS. WNDS DMSHG AFT 01Z...
CIG BLO 10 AND VSBY BLO 3R-F PRSTG PAC CST. LCL CIG BLO 10 AND VSBYS BLO 3R-F ON BERING CST. ELSW 15-25 OVC. VSBYS 3-5R-F. TOPS 180. SFC WNDS SE 25 KTS TIL 06Z.
OTLK VALID 220800-230200...MVFR CIG RW.
...TURBC...
SIGMETMIKE 1 FOR TURBC VALID 211715/222115 PANC-SEV TURBC BLO 060 FCST 60 NM EITHER SIDE OF LINE FROM DUT TO CDB. NC.
...ICG AND FRZLVL...
AIRMET ICGOCNLY MDT ICGICIP 070-140. ENDG BY 00Z.. FRZLVL 070 LWRG TO 040 BY 06Z.

INTERNATIONAL AREA FORECASTS

Area Forecasts from the surface to 25,000 feet are also prepared in international format for areas in the Atlantic Ocean, Caribbean Sea, and the Gulf of Mexico. Moreover, siginificant weather forecasts for 25,000 feet to 60,000 feet are prepared in chart form and in international text format for the northern and western hemisphere.

Example of an International Area Forecast from the surface to FL250.

FANT2 KWBC 091600
091800Z TO 100600Z

ATLANTIC OCEAN WEST OF A LINE FROM 40N 67W TO 32N 63W. SFC TO FL250.

SYNOPSIS.
RIDGE OVER AREA MOVING TO EAST. FRONTAL SYSTEM MOVING OFF COAST BY 06Z.

SIGNIFICANT CLDS/WX.
N OF 34N AND W OF 71W...PATCHES OVC005/015 TOP 030/040 OTHERWISE BKN/OVC015/025 BKN/OVC200/240. BY 06Z INCREASING IMC IN SHRA/TS SPREADING ACROSS AREA FROM WEST. TS TOPS ABOVE 240.

S OF 34N AND W OF 75W...SCT/BKN 015/250. BY 06Z INCREASING IMC IN SHRA/TS SPREADING ACROSS AREA FROM WEST. TS TOPS ABOVE 240.

ELSEWHERE...CLR OCNL SCT015/025. BY 06Z INCREASING BKN080/100.

ICE.
FZ LVL 080/090 N SLOPING TO 120/130 S. MOD IN SHRA. SEV IN TS.

TURB.
MOD IN SHRA. SEV IN TS.

OUTLOOK.
100600Z TO 101800Z
FRONT CONTINUING SLOWLY EWD. INCREASING IMC IN SHRA/TS SPREADING E OVER AREA. SHRA/TS ENDING SW PORTION AFTER FRONTAL PASSAGE.

Example of weather forecast for FL250 to FL600

FAPA1 KWBC 141610
SIG WX PROG FL250-FL600 VALID 150600Z
ISOL EMBD CB TOPS 400 NE OF 11N173W 14N166W 11N164W 01N174W
ISOL EMBD CB TOPS 400 07N158W 08N137W 11N137W 12N158W 07N158W
ISOL EMBD CB TOPS 400 19N157W 29N140W 32N143W 22N162W 15N162W
MDT OR GRTR TURB AND ICG VCNTY ALL CBS
MDT TURB 310-410 19N145W 25N144W 19N163W 15N162W 19N145W

The wording of the International Area Forecasts closely follows domestic Area Forecasts, except international contractions are used which may differ slightly from domestic contractions. Some exceptions are:

SHRA - Rain showers
TS - Thunderstorm
SEV - Severe
ICE - Icing
IMC - Instrument Meteorological Conditions

The groups of numbers and letters are the boundary points of the areas in latitude and longitude. For example "11N173W" is latitude 11 degrees north and longitude 173 degrees west.

TWEB ROUTE FORECASTS AND SYNOPSIS

The TWEB Route Forecast is similar to the Area Forecast except information is contained in a route format. Forecast sky cover (height and amount of cloud bases), cloud tops, visibility (including vertical visibility), weather, and obstructions to vision are described for a corridor 25 miles on either side of the route. Cloud bases and tops are always MSL unless noted. Ceilings are always above ground level (AGL).

A Synopsis, included with each grouping of Route Forecasts, is a brief statement of the weather systems affecting the route during the forecast valid period.

The TWEB Route Forecasts and Synopsis are prepared by WSFOs for more than 300 selected routes over the contiguous U.S. (Figure 1-6). These forecasts are used in the Transcribed Weather Broadcasts (TWEB), Telephone Information Briefing Service (TIBS), and Pilot's Automatic Telephone Weather Answering Service (PATWAS) transcriptions described in Section 1. Individual route forecasts and synopses are also available by request/reply service through any FSS or WSO.

The TWEB Route Forecasts and Synopses are issued by the WSFOs three times per day according to time zone (section 14 for issuance times). The TWEB forecast is valid for a 15-hour period. This schedule provides 24-hour coverage with most frequent updating during the hours of greatest general aviation activity.

An example of a TWEB Synopsis:

BIS SYNS 250924. LO PRES TROF MVG ACRS ND TDA AND TNGT. HI PRES MVG SEWD FM CANADA INTO NWRN ND BY TNGT AND OVR MST OF ND BY WED MRNG.

BIS - Bismark, ND. WSFO issuing the Synopsis and Route Forecasts
SYNS - Synopsis for the area covered by the Route Forecasts
25 - 25th day of the month
0924 - Valid from 09Z on the 25th to 00Z on the 26th (15 hours).
(Rest of message)

Low pressure trough moving across North Dakota today and tonight. High pressure moving southeastward from Canada into northwestern North Dakota by tonight and over most of North Dakota by Wednesday morning.

An example of a TWEB Route Forecast:

249 TWEB 250924 GFK-MOT-ISN. ALL HGTS MSL XCP CIGS. GFK VCNTY CIGS AOA 5 THSD TILL 12Z OTRW OVER RTE CIGS 1 TO 3 THSD VSBY 3 TO 5 MI IN LGT SNW WITH CONDS BRFLY LWR IN HVYR SNW SHWRS.

249 - Route number
TWEB - TWEB Route Forecast
25 - 25th day of the month
0924 - Valid 09Z on the 25th to 00Z on the 26th (15 hours)
GFK-MOT-ISN - Route: Grand Forks to Minot to Williston, ND
(Rest of message)

All heights above mean sea level except ceilings - Grand Forks vicinity...Ceilings at or above 5,000 feet until 1200Z. Otherwise over route...ceilings 1,000 to 3,000 feet...visibility 3 to 5 miles in light snow with conditions briefly lower in heavier snow showers.

When visibility is NOT stated, it is implied to be greater than 6 miles.

Because of their varied accessibility and route format, these forecasts are important and useful weather information that is available to the pilot for flight operations and planning.

WINDS AND TEMPERATURES ALOFT FORECAST (FD)

Winds and temperatures aloft are forecast for specific locations in the contiguous U.S., as shown in Figure 1-3. FD forecasts are also prepared for a network of locations in Alaska and Hawaii as shown in Figure 1-3A. Forecasts are made twice daily based on 00Z and 12Z data for use during specific time intervals.

Below is a sample FD message containing a heading and six FD locations. The heading always includes the time during which the FD may be used (1700-2100Z in the example) and a notation "TEMPS NEG ABV 24000." Since temperatures above 24,000 feet are always negative, the minus sign is omitted.

FD KWBC 151640

BASED ON 151200Z DATA

VALID 151800Z FOR USE 1700-2100Z TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
ALA			2420	2635-08	2535-18	2444-30	245945	246755	246862
AMA		2714	2725+00	2625-04	2531-15	2542-27	265842	256352	256762
DEN			2321-04	2532-08	2434-19	2441-31	235347	236056	236262
HLC		1707-01	2113-03	2219-07	2330-17	2435-30	244145	244854	245561
MKC	0507	2006+03	2215-01	2322-06	2338-17	2348-29	236143	237252	238160
STL	2113	2325+07	2332+02	2339-04	2356-16	2373-27	239440	730649	731960

Forecast Levels

The line labelled "FT" shows 9 to 11 standard FD levels. The 45,000 foot and 53,000 foot levels are electronically transmitted and are available in the communications system. The pilot may request these levels from the FSS briefer or NWS meteorologist. Through 12,000 feet, the levels are true altitude, and above 18,000 feet, the levels are pressure altitude. The FD locations are transmitted in alphabetical order.

Note that some lower-level wind groups are omitted. No winds are forecast within 1,500 feet of station elevation. Also, no temperatures are forecast for the 3,000 foot level or for any level within 2,500 feet of

station elevation.

A 4-digit group shows wind direction, in reference to true north, and wind speed. Look at the St. Louis (STL) forecast for 3,000 feet. The group 2113 means the wind is from 210 degrees at 13 knots. The first two digits give direction in tens of degrees and the second two digits are the wind speed in knots.

A 6-digit group includes forecast temperatures. In the STL forecast, the coded group for 9,000 feet is 2332+02. The wind is from 230 degrees at 32 knots and the temperature is plus 2 degrees Celsius.

If a coded direction is more than "36," then the wind speed is 100 knots or more. Therefore, if the wind direction number is between 51 and 86, the wind speed will be over 100 knots. For example, the STL forecast for 39,000 feet is "731960." The wind direction is from 230 degrees (73-50=23) and the speed is 119 knots (100+19= 119). The temperature is minus 60 degrees Celsius.

If the wind speed is forecast to be 200 knots or greater, the wind group is coded as 199 knots. For example, "7799" is decoded as 270 degrees at 199 knots or greater.

When the forecast speed is less than 5 knots, the coded group is "9900" and read, "LIGHT AND VARIABLE."

Examples of decoding FD winds and temperatures:

Coded	Decoded
9900+00	Wind light and variable, temperature 0 degrees Celsius
2707	270 degrees at 7 knots
850552	350 degrees (85-50=35) at 105 knots (100+05=105), temperature -52 degrees Celsius

SPECIAL FLIGHT FORECAST

When planning a special category flight and scheduled forecasts are insufficient to meet the need. The pilot may request a special flight forecast through any FSS or WSO. Special category flights are hospital or rescue flights; experimental, photographic, or test flights; records attempts; and mass flights (such as air tours, air races and fly-aways from special events).

Pilots should make requests far enough in advance to allow ample time for preparing and transmitting the forecast. Advance notice of 6 hours is desirable. In making a request, the pilot should give the:

1. Aircraft mission
2. Number and type of aircraft
3. Point of departure
4. Route of flight (including intermediate stops, destination, alternates)
5. Estimated time of departure
6. Time en route
7. Flight restrictions (such as VFR, below certain altitudes, etc.)
8. Time forecast is needed

The forecast is written in plain language contractions as in the example:

SPL FLT FCST ABQ-PHOTO MISSION-ABQ 121500Z. THIN CI CLDS AVGG LESS THAN TWO TENTHS CVR. VSBY MORE THAN 30. WNDS AND TEMPS ALF AT FLT ALTITUDE 2320+03. ABQ WSFO 052300Z.

CENTER WEATHER SERVICE UNIT (CWSU) PRODUCTS

Center Weather Service Unit products are issued by the CWSU meteorologist located in the ARTCCs. Coordination between the CWSU meteorologist and the nearby NWS WSFO is extremely important because both can address the same event. If time permits, coordination should take place before the CWSU meteorologist issues a product.

METEOROLOGICAL IMPACT STATEMENT (MIS)

A Meteorological Impact Statement (MIS) is an unscheduled traffic/flight operations planning forecast of conditions expected to begin beyond 2 hours but within 12 hours after issuance. This enables the impact of expected weather conditions to be included in air traffic control decisions in the near future.

A MIS will be issued when the following three conditions are met:

1. If any one of the following conditions are forecast:
   a. convective SIGMET criteria
   b. moderate or greater icing and/or turbulence
   c. heavy or freezing precipitation
   d. low IFR conditions
   e. surface winds/gusts 30 knots or greater
   f. low-level wind shear within 2,000 feet of the surface
   g. volcanic ash, dust or sandstorm
2. If the impact occurs on air traffic flow within the ARTCC area of responsibility.
3. If the forecast lead time (the time between issuance and outset of a phenomenon), in the forecaster's judgment, is sufficient to make issuance of a Center Weather Advisory (CWA) unnecessary.

An example of a MIS:

ZMP MIS 01 VALID 041200-050100
ISOLD LVL 2-4 TSTMS TOPS 350-450 MOVG FM 2925 OVR NW ND. TSTMS MOVG INTO E ND SD W MN AFT 18Z AND RMG IN CLSTRS AFT 22Z TOPS 400-500.

This MIS from the Minneapolis, MN, ARTCC is the first issuance of the day. It was issued at 1200Z on the 4th and is valid until 0100Z on the 5th.

CENTER WEATHER ADVISORY (CWA)

A Center Weather Advisory (CWA) is an unscheduled in-flight air crew, flow control, air traffic *advisory* for use in anticipating and avoiding adverse weather conditions in the en route and terminal areas. The CWA is *not* a flight planning forecast but a *nowcast* for conditions beginning within the next two hours. Maximum valid time of a CWA is two hours, no more than two hours between issuance time and "valid until time." If conditions are expected to continue beyond the valid period, a statement will be included in the Advisory.

A CWA may be issued for the following three situations:

1. As a supplement to an *existing* Inflight Advisory or Area Forecast (FA) section for the purpose of improving or updating the definition of the phenomenon in terms of location, movement, extent, or intensity *relevant* to the ARTCC area of responsibility. This is important for the following reason. A SIGMET for severe turbulence was issued by the NAWAU unit and the outline covered the entire ARTCC area for the total four-hour valid time period. However, the Advisory may only cover a relatively small portion of the ARTCC area at any one time during the four-hour period.
2. When an Iinflight Advisory has not yet been issued but conditions meet Inflight Advisory criteria based on current pilot reports and the information must be disseminated sooner than the NAWAU unit can issue the Inflight Advisory. In this case of an impending SIGMET, the CWA will be issued as an urgent "UCWA" to allow the fastest possible dissemination.
3. When Inflight Advisory criteria is not met but conditions are or will shortly be adversely affecting the safe flow of air traffic within the ARTCC area of responsibility.

An example of a CWA:

ZKC3 CWA 032140
ZKC CWA 301 VALID UNTIL 032340
ISOLD SVR TSTM OVR COU MOVG SWWD 10 KTS. TOP 610. WND GSTS TO 55 KTS. HAIL TO 1 INCH RPRTD AT COU. SVR TSTM CONTG BYD 2340.

This is a CWA issued from the Kansas City, MO, ARTCC. The "3" after the ZKC in the first line denotes this CWA has been issued for the third weather phenomena to occur for the day. The "301" in the second line denotes the phenomena number again (3) and the issuance number (01) for this phenomena. The CWA was issued at 2140Z and is valid until 2340Z.

HURRICANE ADVISORY (WH)

When a hurricane threatens a coast line, but is located at least 300 nm offshore, an abbreviated Hurricane Advisory (WH) is issued to alert aviation interests. The Advisory gives location of the storm center, its expected movement, and the maximum winds in and near the storm center. It does not contain details of associated weather, as specific ceilings, visibilities, weather, and hazards that are found in the Area Forecasts, Terminal Forecasts, and Inflight Advisories.

An example of an abbreviated Aviation Hurricane Advisory:

MIA WH 181010
HURCN BOB AT 1000Z CNTRD 29.4N 74.2W OR 400 NMI E OF JACKSONVILLE FL EXPCTED TO MOV N ABT 12 KT. MAX WNDS 110 KT OVR SML AREA NEAR CNTR AND HURCN WNDS WITHIN 55-75 NMI.

CONVECTIVE OUTLOOK (AC)

A Convective Outlook (AC) describes the prospects for general thunderstorm activity during the following 24 hours. Areas in which there is a high, moderate, or slight risk of severe thunderstorms are included as well as areas where thunderstorms may approach severe limits (approaching is defined as winds greater than or equal to 35 knots but less than 50 knots and/or hail equal to or greater than 1/2 inch in diameter). Refer to the "Severe Weather Outlook Chart" (Section 11) for "risk" definitions. Forecast reasoning is also included in all ACs.

Outlooks are transmitted by the National Severe Storm Forecast Center (NSSFC) in Kansas City, MO, at 0700Z and 1500Z. Forecasts in each AC are valid until 1200Z the next day and are used to prepare and

update the Severe Weather Outlook Chart. Use the Outlook primarily for planning flights later in the day.

Severe thunderstorm criteria:

1. Winds equal to or greater than 50 knots at the surface or,
2. Hail equal to or greater than 3/4 inch diameter at the surface or,
3. Tornadoes

An example of a Convective Outlook:

MKC AC 280700
CONVECTIVE OUTLOOK..REF AFOS NMCGPH940
VALID 281200 - 291200Z

THERE IS A MDT RISK OF SVR TSTMS OVER PTNS ERN AL..MUCH OF GA..SC..NC..THE SE HALF OF VA..AND EXTRM SRN MD..TO RGT OF LN FM SAV MGR CEW SEM RMG HSS ROA CHO WAL.

THERE IS A SLGT RISK OF SVR TSTMS TO RGT OF LN FM MOB JAN MEM BNA LOZ IAD ACY ..CONT..WAL CHO ROA HSS RMG SEM CEW MGR SAV..CONT VRB FMY.

GEN TSTMS ARE FCST TO RGT OF LN FM BLI YKM 4BW WMC TVL SFO..CONT..LCH SHV HOT PAH JST NEL.
STG SFC LO OVR WRN IN EXPCD TO MOV ENE AND DPN DURG NEXT 24 HRS. STLT INDCS UPR LVL IMPULSE FM WRN TN INTO SW AL ROTATING ARND TROF ABT 45 KTS. STG TSTMS CURRENTLY MOVG ACRS AL AHD OF UPR VORT MAX EXPCD TO CONT MOVG E. AMS OVR SE U.S. RMNS MOIST AND UNSTBL BNTH FVRBL UPR LVL DIFLUENCE. SGFNT SVR TSTMS EXPCD FM GA NE INTO SE VA WHERE LO LVL WRM ADVCTN AND CNVRGNC WL BE CONCENTRATED.

ISOLD TSTMS EXPCD TO DVLP PTNS N PAC CST SPRDG INLAND AFT 00Z AS CD AIR ALF ASSOCD WITH NEXT UPR SYS APCHS WRN U.S.
...KLOTH...

SEVERE WEATHER WATCH BULLETINS (WW) and ALERT MESSAGES (AWW)

A severe weather watch bulletin (WW) defines areas of possible severe thunderstorms or tornado activity. The bulletins are issued by the National Severe Storm Forecast Center at Kansas City, MO. WWs are unscheduled and are issued as required.

A Severe Thunderstorm Watch describes areas of expected severe thunderstorms. A Tornado Watch describes areas where the threat of tornadoes exists.

In order to alert the WSFOs, WSOs, CWSUs, FSSs and other users, a preliminary message called the Alert Severe Weather Watch message (AWW) is sent before the main bulletin.

An example of a preliminary message:

MKC AWW 281909
WW 56 TORNADO GA SC NC VA AND ADJ CSTL WTRS 282000Z - 290300Z

AXIS..70 STATUTE MILES EITHER SIDE OF LINE..30 W AGS-/AUGUSTA GA/ TO 30 NE ECG/ELIZABETH CITY NC/
HAIL SURFACE AND ALOFT..3 INCHES. WIND GUSTS..70 KNOTS. MAX TOPS TO 500. MEAN WIND VECTOR 250/60.

Soon after the preliminary message goes out, the actual Watch bulletin itself is issued. A Severe Weather Watch is in the following format:

1. Type of severe weather watch, watch area, valid time period, type of severe weather possible, watch axis, meaning of a watch, and a statement that persons should be on the lookout for severe weather.
2. Other watch information, i.e. references to previous watches.
3. Phenomena, intensities, hail size, wind speed (knots), maximum CB tops and estimated cell movement (mean wind vector).
4. Cause of severe weather.
5. Information on updating ACs.

An example of a Watch bulletin:

MKC WW 281914

BULLETIN - IMMEDIATE BROADCAST REQUESTED
TORNADO WATCH NUMBER 56
NATIONAL WEATHER SERVICE KANSAS CITY MO
214 PM EST WED MAR 28 1984

A..THE NATIONAL SEVERE STORMS FORECAST CENTER HAS ISSUED A TORNADO WATCH FOR

MOST OF SOUTH CAROLINA
MOST OF CENTRAL AND EASTERN NORTH CAROLINA
PARTS OF SOUTHEAST VIRGINIA
PARTS OF EASTERN GEORGIA
ADJOINING COASTAL WATERS

FROM 3 PM EST UNTIL 10 PM EST TODAY.

B..TORNADOES..LARGE HAIL..DANGEROUS LIGHTNING AND DAMAGING THUNDERSTORM WINDS ARE POSSIBLE IN THESE AREAS.

THE TORNADO WATCH AREA IS ALONG AND 70 STATUTE MILES EITHER SIDE OF A LINE FROM 30 MILES WEST OF AUGUSTA GEORGIA TO 30 MILES NORTHEAST OF ELIZABETH NORTH CAROLINA.

REMEMBER..A TORNADO WATCH MEANS CONDITIONS ARE FAVORABLE FOR TORNADOES AND SEVERE THUNDERSTORMS IN AND CLOSE TO THE WATCH AREA. PEOPLE IN THESE AREAS SHOULD BE ON THE LOOKOUT FOR THREATENING WEATHER CONDITIONS AND LISTEN FOR LATER STATEMENTS AND POSSIBLE WARNINGS.

C..TORNADOES AND A FEW SVR TSTMS WITH HAIL SFC AND ALF TO 3 IN. EXTRM TURBC AND SFC WND GUSTS TO 70 KT. A FEW CBS WITH MAX TOPS TO 500. MEAN

WIND VECTOR 250/60.

D..PARAMETERS IN CAROLINAS VERY STG WITH STG LOW LVL FLOW AND CNVRGNC ALG WITH UNSTABLE AMS. MESO LOW MVG RPDLY THRU ERN AL WILL CONT ENE INTO CAROLINAS THIS EVENG. MEANWHILE SVR TSTMS LIKELY DVLPG IN ADVANCE THIS AFTN DUE TO ABV MENTIONED CONDS.

Status reports are issued as needed to show progress of storms and to delineate areas no longer under the threat of severe storm activity. Cancellation bulletins are issued when it become evident that no severe weather will develop or that storms have subsided and are no longer severe.

When tornadoes or severe thunderstorms have developed, WSOs, WSFOs, and WFOs issue local warnings.

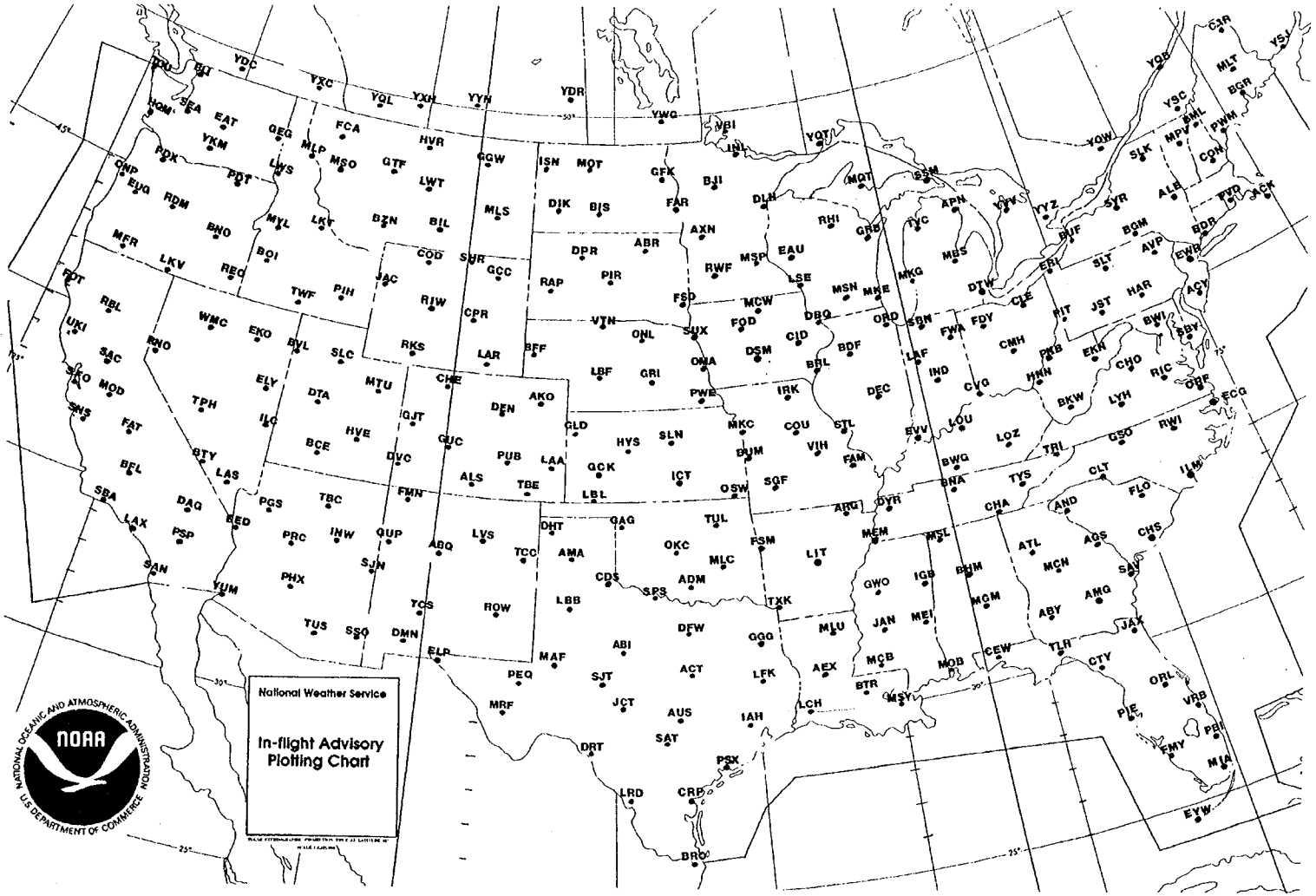


FIGURE 4-1. In-flight Advisory Plotting Chart

FIGURE 4-2. Geographical Areas and Terrain Features

Section 5

SURFACE ANALYSIS CHART

A surface analysis is commonly referred to as a surface weather analysis chart. The surface analysis chart is a computer-prepared chart that covers the contiguous 48 states and adjacent areas. The chart is transmitted every three hours. Figure 5-1 is a section of a surface weather chart and Figure 5-2 illustrates the symbols depicting fronts and pressure centers.

VALID TIME

Valid time of the chart corresponds to the time of the plotted observations. A date-time group in Universal Coordinated Time (UTC) tells the user when conditions portrayed on the chart were occurring.

ISOBARS

Isobars are solid lines depicting the sea level pressure pattern and are usually spaced at intervals of 4 millibar (mb), or hectoPascals (hPa) in metric units (1 millibar = 1 hectoPascal). When the pressure gradient is weak, dashed isobars are sometimes inserted at 2 mb/hPa intervals to more clearly define the pressure pattern. Each isobar is labelled by a two-digit number. For example, 32 signifies 1032.0 mb/hPa, 00 signifies 1000.0 mb/hPa, and 92 signifies 992.0 mb/hPa.

PRESSURE SYSTEMS

The letter "L" denotes a low pressure center and the letter "H" denotes a high pressure center. The pressure of each center is indicated by a three or four digit number which is the central pressure in millibars.

FRONTS

The analysis shows frontal positions and types of fronts by the symbols in Figure 5-2. The "pips" on the front indicated the type of front and point in the direction toward which the front is moving. Pips on both sides of a front indicate a stationary front (little or no movement). Briefing offices sometimes color the symbols to facilitate use of the map.

A three-digit number near a front classifies it as to type, Table 5-1; intensity, Table 5-2; and character, Table 5-3. A bracket ([or]) before or after the number "points" to the front the number refers to. For example, in Figure 5-1, the front extending from central Georgia across the Gulf of Mexico to south Texas is labeled "457." This means a cold front ("4" from Table 5-1), moderate with little or no change ("5" in Table 5-2) and with waves along the front ("7" in Table 5-3). The waves along the front may be weak, low pressure centers which either are not indicated or are simply one part of the front moving faster than the other. The triangular pips also identify this front as a cold front. The pips point southeast indicating the cold front is moving to the southeast.

Two short lines across a front indicate a change in classification. In Figure 5-1 note that two lines cross the front in western Arizona. The front changes from "420" to "629". In this case the cold front from the Pacific into western Arizona changes to an occluded front in southern Nevada.

TROUGH AND RIDGES

A trough of low pressure with significant weather will be depicted as a thick, dashed line running through the center of the trough and identified with the word "TROF". The symbol for a ridge of high pressure is very rarely, if at all, depicted (Figure 5-2).

OTHER INFORMATION

The observations from a number of stations are plotted on the chart to aid in analyzing and interpreting the surface weather features. These plotted observations are referred to as station models.

There are two primary types of station models plotted on the chart. Those with a round station symbol are observations from locations where the observations are taken by observers. The locations with a square station symbol are observations from automated sites. Other plotting models which appear over water on the chart are data from ships, buoys, and offshore oil platforms.

Figure 5-3 is an example of a station model which shows where the weather information is plotted. Figure 5-4 through Figure 5-7 help explain the decoding of the station model.

A legend is printed on each chart stating that it is the Surface Analysis, the date and time of the chart, with additional information regarding the automated observations sites and a volcanic ash symbol.

USING THE CHART

The surface analysis chart provides a ready means of locating pressure systems and fronts. It also gives an overview of winds, temperatures and dew point temperatures at chart time. When using the chart, keep in mind that weather moves and conditions change. Using the surface analysis chart in conjunction with other information gives a more complete weather picture.

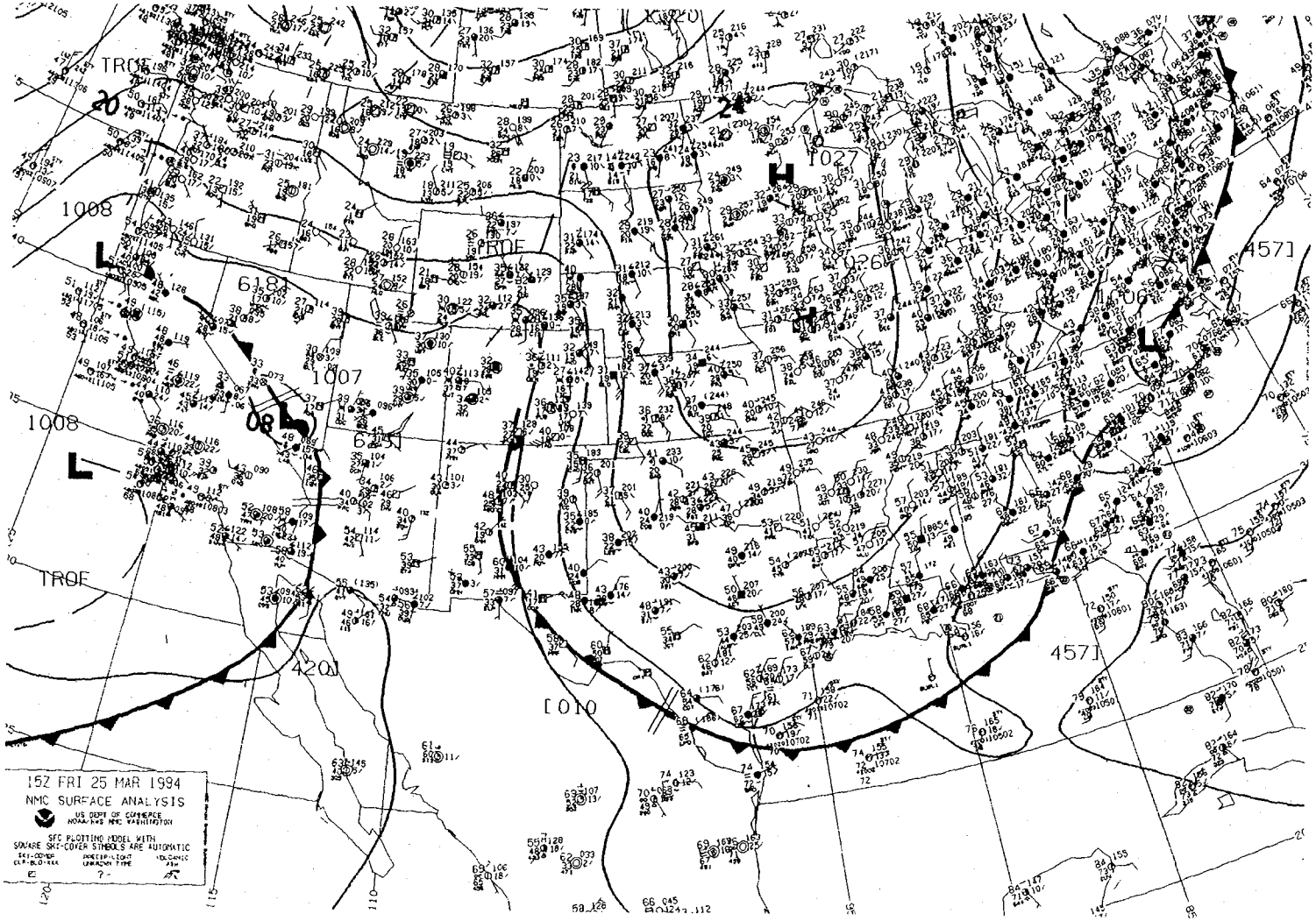


FIGURE 5-1. Surface Weather Analysis

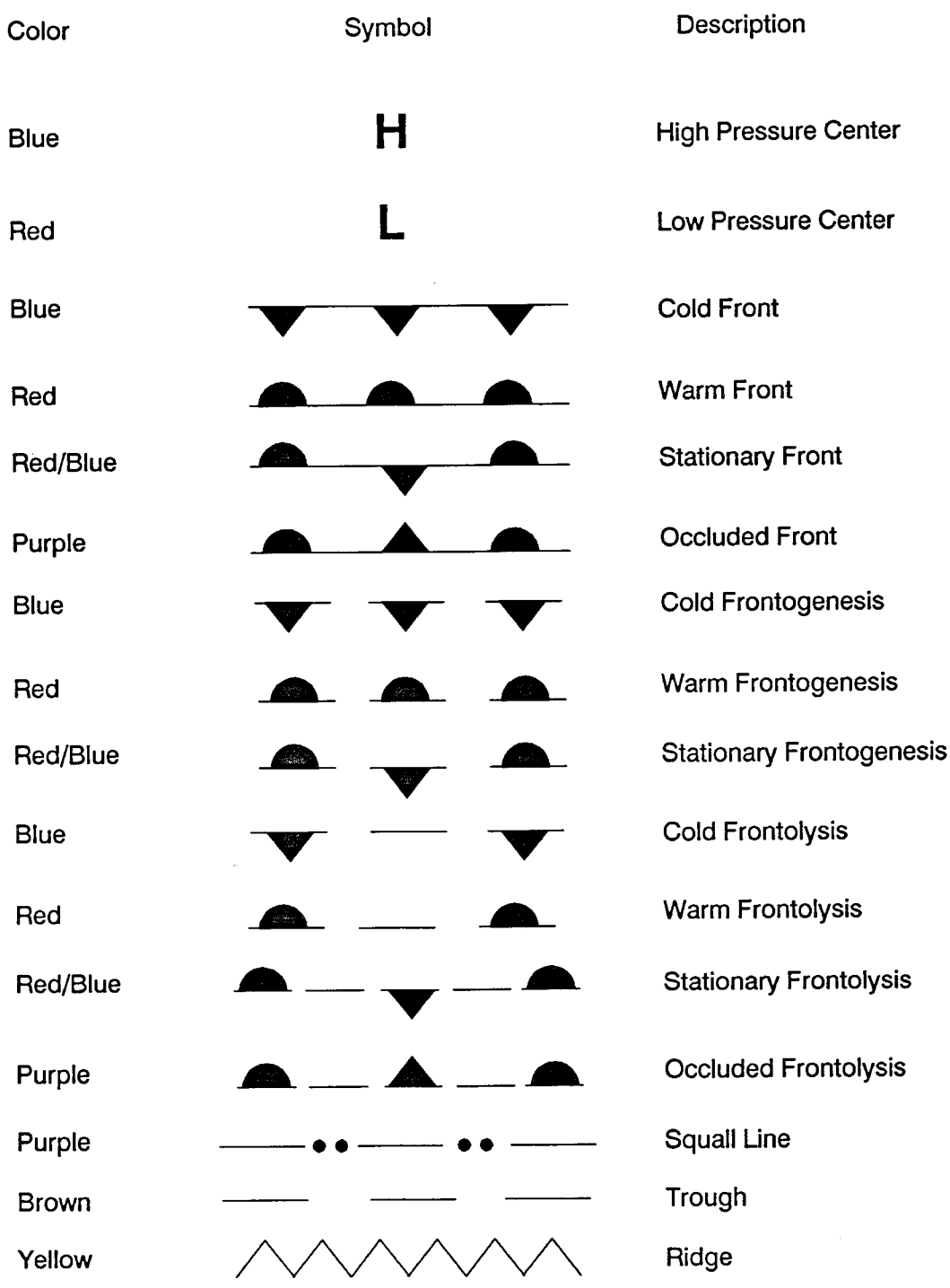
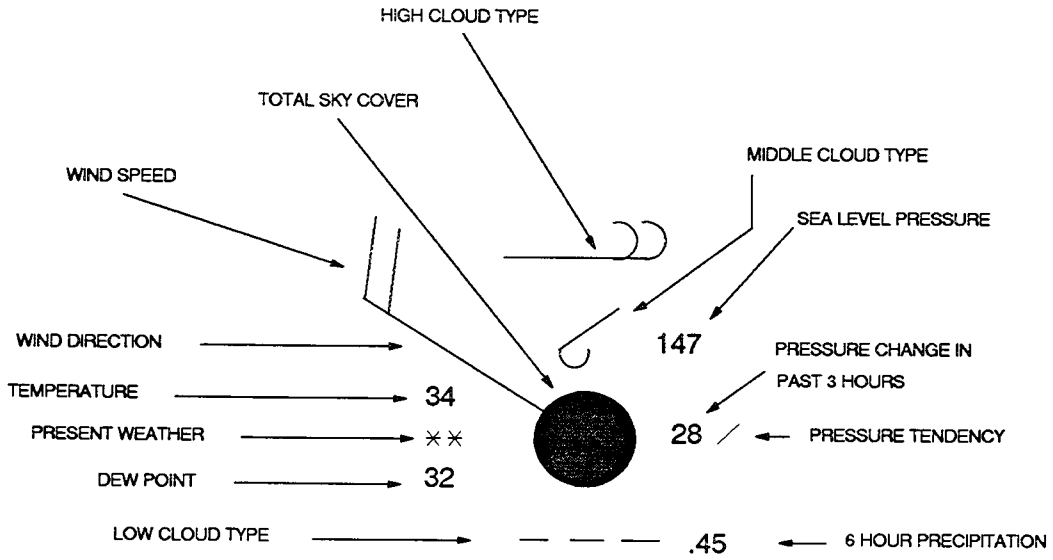
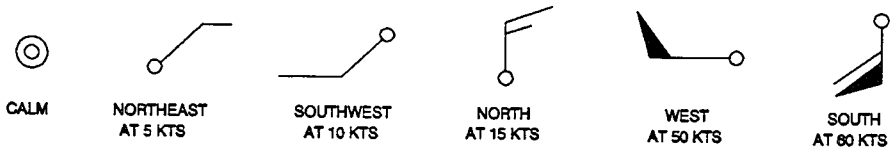


FIGURE 5-2. List of symbols on the surface analysis. Colors are those suggested for on-station use. NOTE: A trough line usually is further identified by the word "TROF".



1. Total sky cover: OVERCAST (Figure 5-4).
2. Temperature: 34 DEGREES F, Dew Point: 32 DEGREES F.
3. Wind: FROM THE NORTHWEST AT 20 KNOTS (relative to True North).

Examples of wind direction and speed



4. Present Weather: CONTINUOUS LIGHT SNOW (Figure 5-6).
5. Predominant low, middle, high cloud reported: STRATO FRACTUS OR CUMULUS FRACTUS OF BAD WEATHER, ALTOCUMULUS IN PATCHES, AND DENSE CIRRUS (Figure 5-7).
6. Sea Level Pressure: 1014.7 MILLIBARS (mbs).
   NOTE: Pressure is always shown in 3 digits to the nearest tenth of a millibar. For 1000 mbs or greater, prefix a "10" to the 3 digits. For less than 1000 mbs, prefix a "9" to the 3 digits.
7. Pressure change in past 3 hours: INCREASED STEADILY OR UNSTEADILY BY 2.8 mbs. The actual change is in tenths of a millibar. (Figure 5-5)
8. 6-hour precipitation: 45 hundredths of an inch. The amount is given to the nearest hundredth of an inch.

FIGURE 5-3. Station model and explanation.

TABLE 5-1. Type of Front

Code Figure	Description
0	Quasi-stationary at surface
1	Quasi-stationary above surface
2	Warm front at surface
3	Warm front above surface
4	Cold front at surface
5	Cold front above surface
6	Occlusion
7	Instability line
8	Intertropical front
9	Coverage line

TABLE 5-2. Intensity of front

Code Figure	Description
0	No specification
1	Weak, decreasing
2	Weak, little, or no change
3	Weak, increasing
4	Moderate, decreasing
5	Moderate, little, or no change
6	Moderate, increasing
7	Strong, decreasing
8	Strong, little, or no change
9	Strong, increasing

TABLE 5-3. Character of front

Code Figure	Description
0	No specification
1	Frontal area activity, decreasing
2	Frontal area activity, little change
3	Frontal area activity, increasing
4	Intertropical
5	Forming or existence expected
6	Quasi-stationary
7	With waves
8	Diffuse
9	Position doubtful

Symbol	Total Sky Cover
	Sky Clear (less than 1/10)
	1/10 to 5/10 inclusive (Scattered)
	6/10 to 9/10 inclusive (Broken)
	10/10 (Overcast)
	Sky obscured or partially obscured

FIGURE 5-4. Sky cover symbols.

Description of Characteristic		
Primary Unqualified Requirement	Additional Requirements	Graphic
HIGHER Atmospheric pressure now higher than 3 hours ago.	Increasing then decreasing	
	Increasing then steady; or	
	increasing then increasing more slowly	
	Increasing: Steadily / Unsteadily	
	Decreasing or steady then increasing; or	
	increasing then increasing more rapidly	
THE SAME Atmospheric pressure now same as 3 hours ago	Decreasing then increasing	
	Steady	
	Decreasing then decreasing more slowly	
LOWER Atmospheric pressure now lower than 3 hours ago.	Decreasing then increasing	
	Decreasing then steady or	
	decreasing then decreasing more slowly	
	Decreasing: Steadily / Unsteadily	
	Steady or increasing then decreasing; or	
	decreasing then decreasing more rapidly	

FIGURE 5-5. Barometer tendencies.

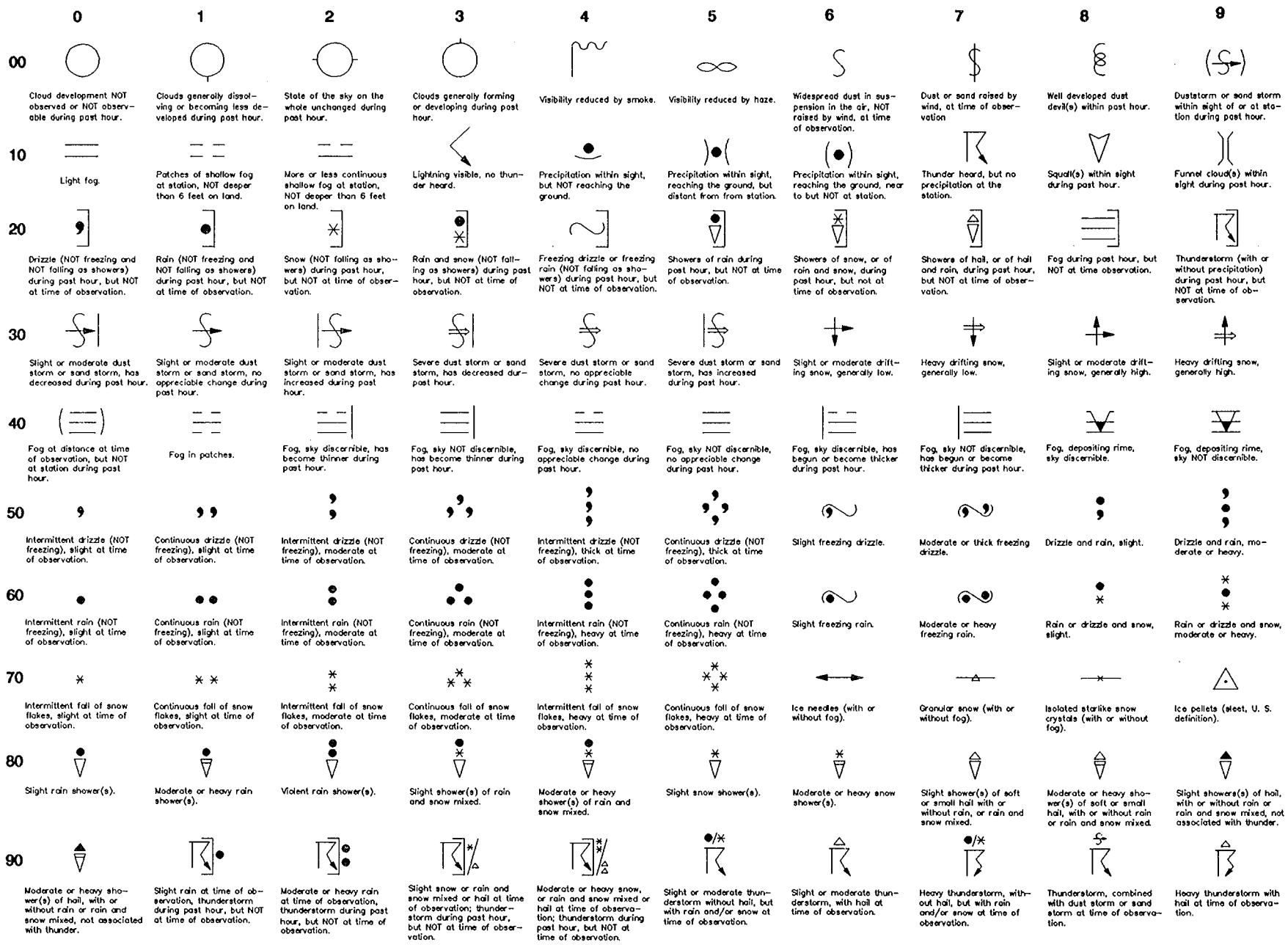


FIGURE 5-6. Present Weather Symbols

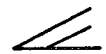
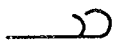
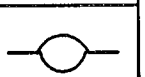
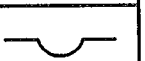
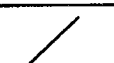
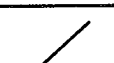
CLOUD ABBREVIATION		C_L	DESCRIPTION (Abridged from W.M.O. Code)		C_M	DESCRIPTION (Abridged from W.M.O. Code)		C_H	DESCRIPTION (Abridged from W.M.O. Code)
St or Fs - Stratus or Fractostratus	1		Cu, fair weather, little vertical development & flattened	1		Thin As (most of cloud layer semitransparent)	1		Filaments of Ci, or "mares tails", scattered and not increasing
Ci - Cirrus	2		Cu, condiderable development, towering with or without other Cu or SC bases at same level	2		Thick As, greater part sufficiently dense to hide sun (or moon), or Ns	2		Dense Ci in Patches or twisted sheaves, usually not increasing, sometimes like remains of CB; or towers tufts
Cs - Cirrostratus	3		Cb with tops lacking clear-cut outlines, but distinctly not cirriform or anvil shaped; with or without Cu, Sc, St	3		Thin Ac, mostly semi-transparent; cloud elements not changing much at a single level	3		Dense Ci, often anvil-shaped derived from or associated Cb
Cc - Cirrocumulus	4		Sc formed by spreading out of Cu; Cu often present also	4		Thin AC in patches; cloud elements continually changing and/or occuring at more than one level	4		Ci, often hook-shaped gradually spreading over the sky and usually thickening as a whole
Ac - Altocumulus	5		Sc not formed by spreading out of Cu	5		Thin Ac in bands or in a layer gradually spreading over sky and usually thickening as a whole	5		Ci and Cs, often in converging bands or Cs alone; generally overspreading and growing denser; the continuous layer not reaching 45 altitude
As - Altostratus	6		St or Fs or both, but no Fs of bad weather	6		Ac formed by the spreading out of Cu	6		Ci & Cs often in converging bands or Cs alone; generally overspreading and growing denser the continuous layer exceeding 45 altitude
Sc - Stratocumulus	7		Fs and/or Fc of bad weather (scud)	7		Double-layered Ac, or a thick layer of Ac, not increasing; or Ac with As and/or Ns	7		Veil of Cs covering the entire sky
Ns - Nimbostratus	8		Cu and Sc (not formed by spreading out of Cu) with bases at different levels	8		Ac in the form of Cu-shaped tufts or Ac with turrets	8		Cs not increasing and not covering entire sky
Cu or Fc - Cumulus or Fractocumulus	9		Cb having a clearly fibrous (cirriform) top, often anvil-shaped, with or without Cu Sc, ST or scud	9		Ac of a chaotic sky, usually at different levels; patches of dense Ci are usually present	9		Cc alone or Cc with some Ci or Cs but the Cc being the main cirriform cloud

FIGURE 5-7. Cloud Symbols

Section 6

WEATHER DEPICTION CHART

The weather depiction chart, Figure 6-1, is computer-prepared from Surface Aviation Observations (SAO). The weather depiction chart gives a broad overview of the observed flying category conditions at the valid time of the chart. This chart begins at 01Z each day, is transmitted at three hour intervals, and is valid at the time of the plotted data.

PLOTTED DATA

Data for the chart comes from the observations reported by both manual and automated observation locations. The automated stations are denoted by a bracket ( ]) plotted to the right of the station circle. The plotted data for each station are:

Total Sky Cover

The amount of sky cover is shown by the station circle shaded as in Table 6-1.

TABLE 6-1. Total sky cover.

Symbol	*Total sky cover*
○	Sky Clear (less than 1/10)
◔	1/10 to 5/10 inclusive (Scattered)
◕	5/10 to 9/10 inclusive (Broken)
●	10/10 (Overcast)
⊗	Sky obscured or partially obscured

Cloud Height or Ceiling

Cloud height above ground level is entered under the station circle in hundreds of feet, the same as coded in a SAO report. If total sky cover is scattered, the cloud height entered is the base of the lowest layer. If total sky cover is broken or greater, the cloud height entered is the ceiling. Broken or greater total sky cover without a height entry indicates thin sky cover. A partially or totally obscured sky is shown by the same sky cover symbol "X". However, a partially obscured sky without a cloud layer above is denoted by the absence of a height entry. A partially obscured sky with clouds above will have a cloud layer or ceiling height entry. A totally obscured sky always has a height entry of the ceiling (vertical visibility into the obscuration).

Weather and Obstructions to Vision

Weather and obstructions to vision symbols are entered to the left of the station circle. Figure 5-6 explains most of the symbols used. When an SAO reports clouds topping ridges, a symbol unique to the weather depiction chart is entered to the left of the station circle:

When several types of weather and/or obstructions to visibility are reported at a station, only the most significant one is entered (i.e. the highest coded number in Figure 5-6).

Visibility

When visibility is 6 miles or less, it is entered to the left of the weather or obstructions to vision symbol. Visibility is entered in statute miles and fractions of a mile. Table 6-2 shows examples of plotted data.

ANALYSIS

The chart shows observed ceiling and visibility by categories as follow:

1. IFR - Ceiling less than 1,000 feet and/or visibility less than 3 miles; hatched area outlined by a smooth line.

2. MVFR (Marginal VFR) - Ceiling 1,000 to 3,000 feet inclusive and/or visibility 3 to 5 miles inclusive; non-hatched area outlined by a smooth line.

3. VFR - No ceiling or ceiling greater than 3,000 feet and visibility greater than 5 miles; not outlined.

The three categories are also explained in the lower right portion of the chart for quick reference.

Referring to Figure 6-1, the MVFR conditions in eastern Tennessee and southeast Arkansas/northwest Mississippi are indicated in areas where nearby plotted stations show only VFR conditions. Note that off the Baja California coast, it is stated that the total stations analyzed for this chart are far more numerous than the number of stations actually plotted. Therefore, there are stations in eastern Tennessee and southeast Arkansas/northwest Mississippi that are not plotted on the chart, but are reporting MVFR conditions.

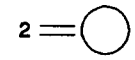
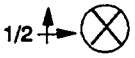
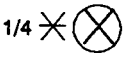
In addition, the chart shows fronts and troughs from the surface analysis for the preceding hour. These features are depicted the same as the surface chart.

USING THE CHART

The weather depiction chart is an ideal place to begin preparing for a weather briefing and flight planning. From this chart, one can get a "birds eye" view of areas of favorable and adverse weather conditions for chart time.

This chart may not completely represent the en route conditions because of variations in terrain and possible weather occurring between reporting stations. Due to the delay between data and transmission time, changes in the weather could occur. One should update the chart with current SAO reports. After initially sizing up the general weather picture, final flight planning must consider forecasts, progs and the latest pilot, radar, and surface weather reports.

TABLE 6-2. Examples of plotting on the Weather Depiction Chart

Plotted	Interpreted
	Few clouds, base 800 feet, visibility more than 6
	Broken sky cover, ceiling 1,200 feet, rain shower, visibility more than 6
	Thin overcast, visibility 5 in haze
	Scattered at 3,000 feet, clouds topping ridges, visibility more than 6
	Sky clear, visibility 2, ground fog or fog
	Sky partially obscured, visibility 1/2, blowing snow, no cloud layers observed
	Sky partially obscured, visibility 1/4, snow, no cloud layers observed
	Overcast, ceiling 1,200 feet, thunderstorm, rain shower, visibility 1
	Data missing

Note: Since a partial and total obscuration (X) is entered as total sky cover, it can be difficult to determine if a height entry is a cloud layer above a partial obscuration or vertical visibility into a total obscuration. Check the SAO.

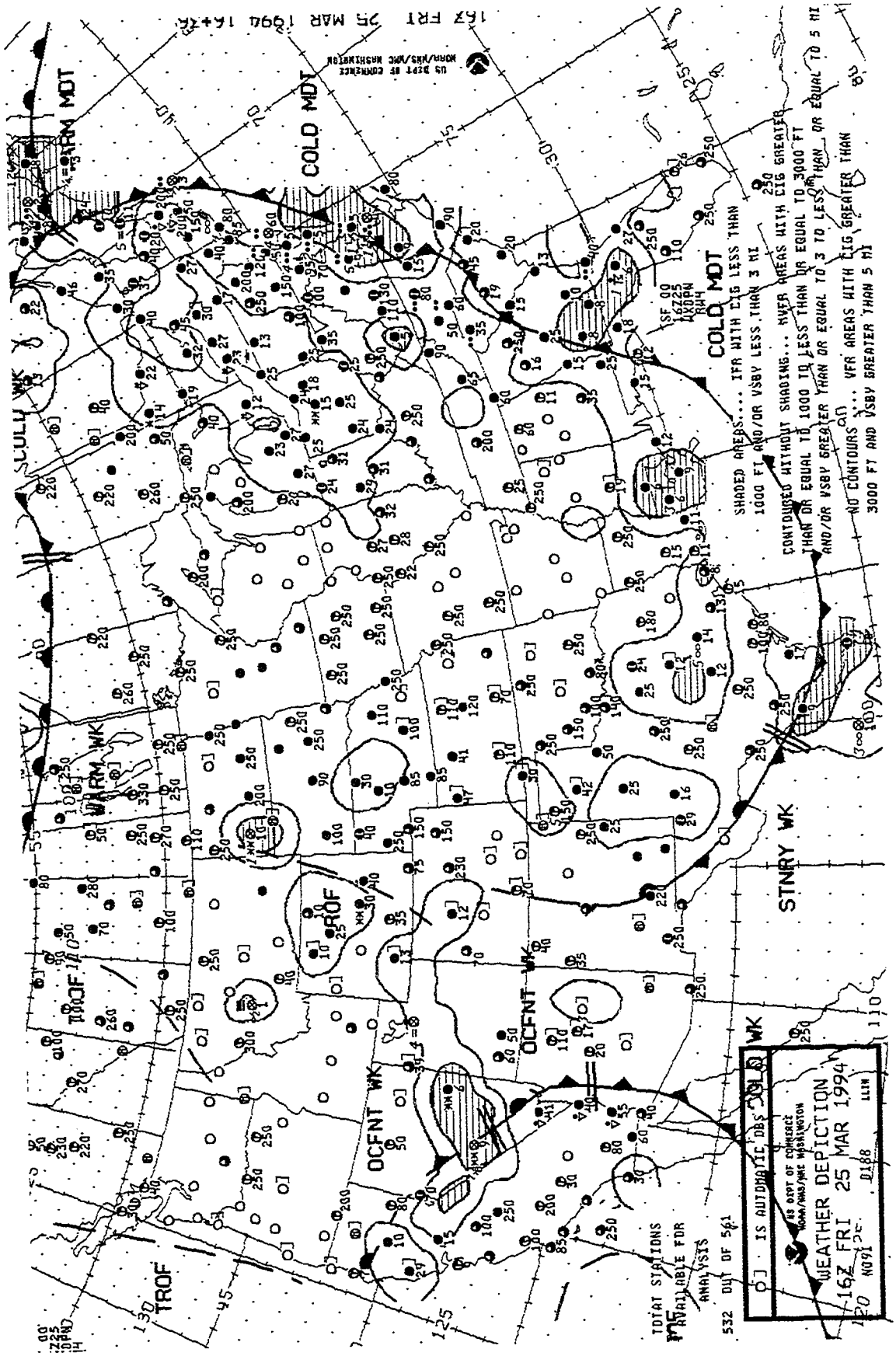


FIGURE 6-1. A Weather Depiction Chart

Section 7

RADAR SUMMARY CHART

A radar summary chart, Figure 7-1, graphically displays a collection of radar weather reports (SDs). Figures 1-1 and 1-2 depict the National Weather Service radar network. This computer-generated chart is constructed from regularly scheduled radar observations and is valid at the time of the reports (H+35), i.e., 35 minutes past each hour. These charts are available between 16 and 24 hours daily depending on the system being used. The chart displays the type of precipitation echoes, their intensity, intensity trend, configuration, coverage, echo tops and bases, and movement. Severe weather watches are plotted if they are in effect when the chart is valid.

ECHO TYPE

Radar primarily detects particles of precipitation size within a cloud or falling from a cloud. The type of precipitation can be determined by the radar operator from the scope presentation in combination with other sources. Table 7-2 lists the symbols used to denote types of precipitation.

INTENSITY AND INTENSITY TREND

The intensity is obtained from the Video Integrator Processor (VIP) and is indicated on the chart by *contours*. The six VIP levels are combined into three contours as indicated in Table 7-2. In Figure 7-1 over southwest Nebraska and northwest Kansas, there is an area of precipitation depicted by one contour. The area would have an intensity of VIP level 1 and possibly VIP level 2. Whether there is a VIP level 2 in the area cannot be determined. However, what can be said is that the maximum intensity is definitely below VIP level 3. When determining intensity levels from this chart, it is recommended that the maximum possible intensity be used. To determine the actual maximum VIP level, the radar weather report (SD) for that time period should be examined.

The intensity trend is indicated by a symbol plotted beside the precipitation type. Looking at Figure 7-1, the rain showers in Virginia (RW-) have decreased in intensity since the last observation. The absence of a trend symbol indicates no change. The area of light to moderate rain (R) and rain showers (RW) over Tennessee and Kentucky, have not changed in intensity from the previous observation. The rain showers in southern California (RW+) have increased in intensity since the last observation.

The actual intensity for frozen precipitation cannot be determined from the contours as the intensity levels are only correlated to liquid precipitation. Intensity trend for frozen precipitation is neither reported on a SD nor the radar summary chart. The "SW+" for the precipitation area in Colorado means the area of snow showers is new, i.e. it was not reported on the last observation. A "S" on the chart means an area of snow is indicated by radar with no reference to intensity trend. Remember the intensity trend symbols; (-) decreasing, (no symbol) no change, and (+) increasing refer to *liquid precipitation only.*

It is important to remember that intensity on the radar summary chart is shown by contours and not by the symbol following the type of precipitation.

ECHO CONFIGURATION AND COVERAGE

The configuration is the arrangement of echoes. There are three designated arrangements; a LINE of echoes, an AREA of echoes, and an isolated CELL. See Section 3 under radar reports for definitions of the three configurations.

Coverage is simply the area covered by echoes. All of the hatched area inside of the contours on the chart is considered to be covered by echoes. When the echoes are reported as a LINE, a line will be drawn through them on the chart. Where there is 8/10 coverage or more, the line is labeled as solid (SLD) at both ends. In the absence of this label it can be assumed that there is less than 8/10 coverage. For example in Figure 7-1, there is a solid line of thunderstorms with intense to extreme rainshowers along the coast of the Florida panhandle.

ECHO HEIGHTS

Echo heights in locations with radars designed for weather detection are obtained by use of range height indicators and are *PRECIPITATION* tops and bases. In those areas not served by National Weather Service radars, the tops are obtained from pilot reports and are actual *CLOUD* tops. Usually, echo height will be missing in the western mountain regions because ARTCC radars are used.

Heights are displayed in hundreds of feet MSL and

should be considered only as approximations because of radar limitations. Tops are entered above a short line while any available bases are entered below. The top height displayed is the highest in the indicated area.

For example:

220 Bases 8,000 feet, Maximum top 22,000 feet
080

500 Bases at surface, Maximum top 50,000 feet

020 Bases 2,000 feet, Maximum top either missing or reported in another place

Absence of a figure below the line indicates that the echo base is at or near the surface. Radar detects tops more readily than bases because precipitation usually reaches the ground. For example, over Kentucky and Tennessee, (see Figure 7-1), the maximum precipitation top in the area is 15,000 to 17,000 feet MSL. The location is indicated by a line drawn from the top value to the location of that top. Further west, the area of snow over Nebraska and Kansas has a base of 7,000 feet MSL and a top of 18,000 feet MSL.

ECHO MOVEMENT

Individual cell movement is indicated by an arrow with the speed in knots entered as a number at the top of the arrow head. Little movement is identified by "LM." Line or area movement is indicated by a shaft and barb combination with the shaft indicating the direction and the barbs the speed. A half barb is 5 knots, a whole barb is 10 knots, and a pennant is 50 knots.

For example, in Figure 7-1, for the area of snow and rain over central California, no cell movement is given, but the area movement is toward the west at 15 knots. Over southern California, no area movement is given, but the cell movement of the rain showers is toward the east at 20 knots.

SEVERE WEATHER WATCH AREAS

Severe weather watch areas are outlined by heavy dashed lines, usually in the form of a large rectangular box. There are two types, tornado watches and severe thunderstorm watches. Referring to Figure 7-1 and Table 7-2, the type of watch and the watch number are enclosed in a small rectangle and positioned as closely as possible to the northeast corner of the watch box. For example, in Figure 7-1, the boxed "WS036" in South Carolina means the watch area in the southeastern U.S. is a severe thunderstorm watch and is the 36th severe weather watch issued so far in the year. The watch number is also printed at the bottom of the chart (in Mexico) together with the issuance time and valid until time.

CANADIAN DATA

Radar data from Canadian radar stations are plotted when available. The stations are Halifax, Holyrood, Mechanics Settlement, Broadview, Elbow, Vivian, Mont Apica, Britt, Carp, Exeter, Montreal, River Harbour, Upsala, Villerpy, King City, Carvel, Vulcan, Cold Lake and McGill. The data is displayed in AZRAN (azimuth-range) format with echo areas outlined by solid lines. Area, line and cell movements are shown in the same manner as U.S. data. An alphanumeric code associated with each echo shows, in order, area coverage, precipitation type, intensity, and intensity trend. Precipitation type and intensity trend are the same as U.S. data. For area coverage, a blank designator represents cells, a 1 equals less than 1/10 coverage, a 4 equals 1/10 to 5/10 coverage, a 7 equals 6/10 to 9/10 coverage, and 10 equals 10/10 coverage. For intensity levels, 0 is very weak, 1 is weak, 2 is moderate, 3 is strong and 4 is very strong. Levels 1 through 4 are comparable to the U.S. VIP levels of 1 through 4.

Canadian echo top reports are converted from meters to feet and are plotted to the nearest hundreds of feet MSL. For example, 197 is 19,700 feet MSL.

It is sometimes difficult to interpret the data when both U.S. and Canadian reports are plotted. Do not confuse a Canadian report with a severe weather watch box. The Canadian radar reports are enclosed by a solid line box, while a severe weather watch box is outlined by a dashed line.

USING THE CHART

The radar summary chart aids in preflight planning by identifying general areas and movement of precipitation and/or thunderstorms. Radar detects ONLY drops or ice particles of precipitation size, it DOES NOT detect clouds and fog. Therefore, the absence of echoes does not guarantee clear weather, and cloud tops may be higher than the tops detected by radar. The chart must be used in conjunction with other charts, reports, and forecasts.

Examine chart notations carefully. Always determine location and movement of echoes. If echoes are anticipated near the planned route, take special note of echo intensity and trend. Be sure to examine the chart for missing radar reports before assuming "no echoes present". For example, the Garden City (GCK) radar report in southwest Kansas is shown as not available (NA). There could be echoes in southwest Kansas but be too far away to be detected by the other surrounding radars.

TABLE 7-1. Explanation of boxed symbols

Symbol	Description
HOOK	A thunderstorm related radar signature that is suspected to be associated with a tornado
HAIL	A thunderstorm related remark when hail has been reported or indicated by radar
LEWP	(Line Echo Wave Pattern) An irregularly shaped line of thunderstorms. Often producing severe weather in the form of tornadoes, large hail, and wind shear due to straight line winds
BWER	(Bounded Weak Echo Region) A thunderstorm related radar signature that is associated with severe thunderstorms
PCLL	A thunderstorm cell that has little or no movement
FNLN	(Fine Line) A narrow non-precipitation pattern indicating low-level wind shear (LLWS) and moderate or greater turbulence

Suppose the planned flight route goes through an area of widely scattered thunderstorms in which no increase is anticipated. If these storms are separated by good VFR weather, they can be visually sighted and circumnavigated. However, widespread cloudiness may conceal the thunderstorms. To avoid these embedded thunderstorms, either using airborne radar or detouring the area would be necessary. Details on avoiding hazards of thunderstorms are given in Chapter 11, Aviation Weather.

Remember that the radar summary chart is for preflight planning only and should be updated by hourly radar reports. Once airborne, the pilot must evade individual storms by inflight observations either by visual sighting, using airborne radar, or by requesting radar echo information from FSS Flight Watch. FSS Flight Watch has access to Radar Remote Weather Displays (RRWDS).

There can be an interpretation problem concerning an area of precipitation that is reported by more than one radar site. For example, station A may report RW- with cell movement toward the northeast at 10 knots. For the same area, station B may be reporting TRW+ with cell movement toward the northeast at 30 knots. This difference in reports may be due to a different perspective and distance of the radar site from the area of echoes. The area may be moving away from station A and approaching station B. The rule of thumb is to use that plotted data associated with the area which presents the greatest hazard to aviation. In this case, the station B report would be the used.

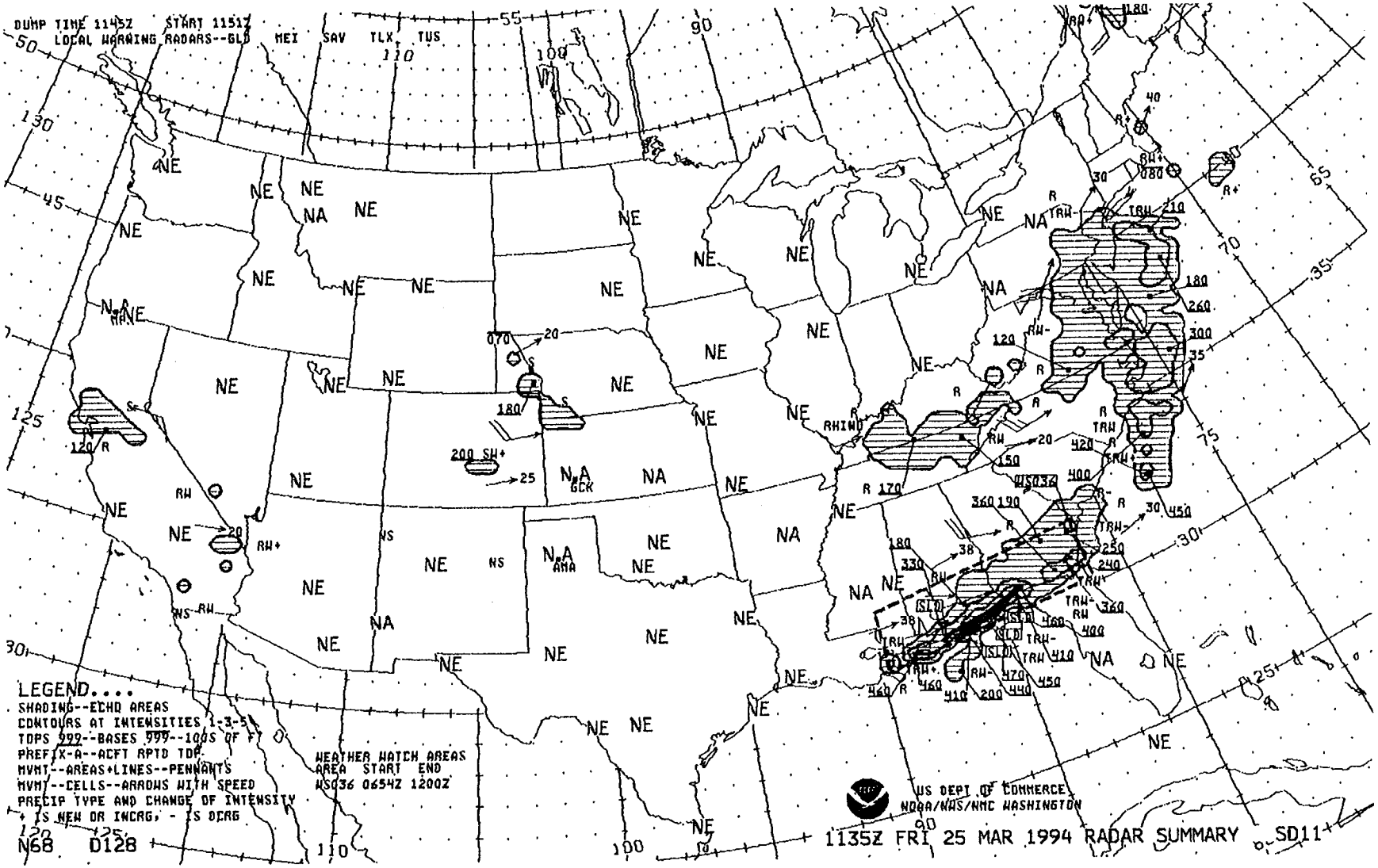
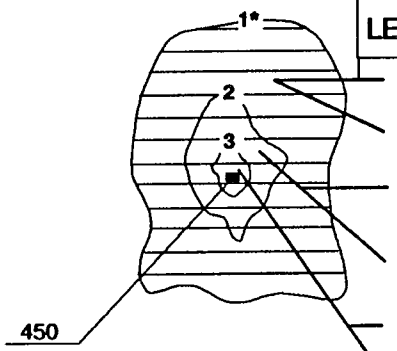


FIGURE 7-1. A Radar Summary Chart



Highest precipitation top in area in hundreds of feet MSL.
(45,000 FEET MSL)

VIP LEVEL	ECHO INTENSITY	PRECIPITATION INTENSITY	RAINFALL RATE in/hr STRATIFORM	RAINFALL RATE in/hr CONVECTIVE
1	WEAK	LIGHT	LESS THAN 0.1	LESS THAN 0.2
2	MODERATE	MODERATE	0.1 - 0.5	0.2 - 1.1
3	STRONG	HEAVY	0.5 - 1.0	1.1 - 2.2
4	VERY STRONG	VERY HEAVY	1.0 - 2.0	2.2 - 4.5
5	INTENSE	INTENSE	2.0 - 5.0	4.5 - 7.1
6	EXTREME	EXTREME	MORE THAN 5.0	MORE THAN 7.1

* The numbers representing the intensity level do not appear on the chart. Beginning from the first contour line, bordering the area, the intensity level is 1-2, second contour is 3-4, and the third contour is 5-6.

SYMBOLS USED ON CHARTS

SYMBOL	MEANING
R	RAIN
RW	RAIN SHOWER
HAIL	HAIL
S	SNOW
IP	ICE PELLETS
SW	SNOW SHOWER
L	DRIZZLE
T	THUNDERSTORM
ZR, ZL	FREEZING PRECIPITATION
NE	NO ECHOES OBSERVED
NA	OBSERVATIONS UNAVAILABLE
OM	OUT FOR MAINTENANCE
STC	STC ON - all precipitation may not be seen
ROBEPS	RADAR OPERATING BELOW PERFORMANCE STANDARDS
RHINO	RANGE HEIGHT INDICATOR NOT OPERATING

SYMBOL	MEANING
+	INTENSITY INCREASING OR NEW ECHO
-	INTENSITY DECREASING
NO SYMBOL	NO CHANGE IN INTENSITY
35	CELL MOVEMENT TO NE AT 35 KNOTS
	LINE OR AREA MOVEMENT TO EAST AT 20 KNOTS
LM	LITTLE MOVEMENT
MA	ECHOES MOSTLY ALOFT
PA	ECHOES PARTLY ALOFT

SYMBOL	MEANING
	LINE OF ECHOES
SLD	8/10 OR GREATER COVERAGE IN A LINE
WS999	SEVERE THUNDERSTORM WATCH
WT999	TORNADO WATCH
LEWP	LINE ECHO WAVE PATTERN
HOOK	HOOK ECHO
BWER	BOUNDED WEAK ECHO REGION
PCLL	PERSISTENT CELL
FNLN	FINE LINE

TABLE 7-2. Key to Radar Summary Chart.

Section 8

SIGNIFICANT WEATHER PROGNOSTIC CHARTS

Significant weather prognostic charts, called "progs" for brevity, portray forecast weather which may influence flight planning. Table 8-1 explains some symbols used on these charts. Significant weather progs are issued both for domestic and international flights.

TABLE 8-1. Some standard weather symbols

Symbol	*Meaning*	*Symbol*	*Meaning*
	Moderate Turbulence		Rain Shower
	Severe Turbulence		Snow Shower
	Moderate Icing		Thunderstorm
	Severe Icing		Freezing Rain
	Rain		Tropical Storm
	Snow		Hurricane (typhoon)
	Drizzle		

NOTE: Character of stable precipitation is the manner in which it occurs. It may be intermittent or continuous. A single symbol denotes intermittent and a pair of symbols denotes continuous.

Examples,

	Intermittent	Continuous
Rain		
Drizzle		
Snow		

Significant weather progs are both manually and computer-prepared for the conterminous U.S. and adjacent areas. The U.S. low-level significant weather prog is designed for domestic flight planning to 24,000 feet MSL and a U.S. high-level prog is for domestic flights from 24,000 feet to 63,000 feet MSL. Chart legends include valid time in UTC.

U.S. LOW-LEVEL SIGNIFICANT WEATHER PROG

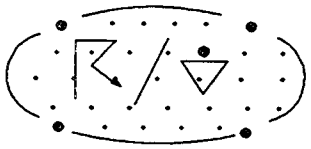
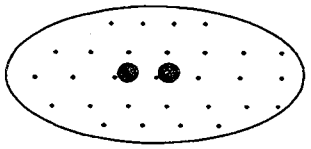
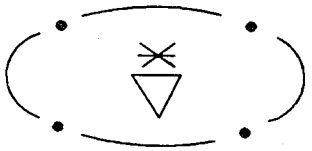
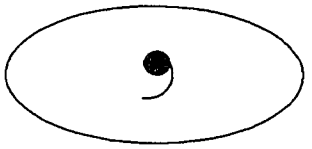
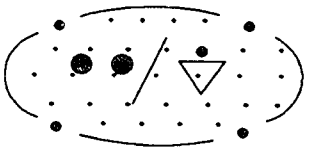
The low-level prog is a four-panel chart as shown in Figure 8-1. The two lower panels are 12- and 24-hour surface progs. The two upper panels are 12- and 24-hour progs of significant weather from the surface to 400 millibars/hectoPascals (24,000 feet MSL). The charts show conditions as they are forecast to be at the valid time of the chart. This chart is issued four times daily with the 12- and 24-hour forecasts based on the 00Z, 06Z, 12Z and 18Z synoptic data. For example, the prog in Figure 8-1 is based on the 12Z, 25 MAR 1994 initial data.

Surface Prog. The two surface prog panels use standard symbols for fronts, significant troughs, and pressure centers explained in section 5. High and Low pressure centers are indicated by a two digit number. These two-digit numbers are underlined on the manually prepared chart, but not on the computer prepared chart. Isobars depicting forecast pressure patterns are included on some 24 hour surface progs.

The surface prog also outlines areas of forecast precipitation and/or thunderstorms as shown in the lower panels of Figure 8-1. Solid lines enclose areas of expected continuous or intermittent (stable) precipitation and dash-dot lines enclose areas of showers and thunderstorms (unstable precipitation). Areas of continuous or intermittent precipitation with embedded showers and thunderstorms are also enclosed by solid lines.

Note that the symbols indicate precipitation type and character (Table 8-1 and 8-2). If precipitation affects half or more of an area, that area is shaded. The absence of shading denotes more sparse precipitation, specifically less than half the areal coverage. Look at the lower left panel of Figure 8-1. At 00Z, the forecast is for rain showers and thunderstorms covering more than half of the area of southern Arkansas and portions of Tennessee, Mississippi, and Alabama. Else-

TABLE 8-2. Significant weather prognostic symbols

Depiction	*Meaning*
	Showery precipitation (Thunderstorms/rain showers) covering half or more of the area.
	Continuous precipitation (rain) covering half or more of the area.
	Showery precipitation (snow showers) covering less than half of the area.
	Intermittent precipitation (drizzle) covering less than half of the area.
	Showery precipitation (rain showers) embedded in an area of continuous rain covering more than half of the area.

where over much of the southeastern U.S., rain showers and thunderstorms covering less than half the area are expected.In the area of precipitation over California, Nevada, and Utah, the dashed line through central California represents the rain/snow line.

Significant Weather. The upper panels of Figure 8-1 depicts IFR, MVFR, turbulence, and freezing levels. Note that the legend near the center of the chart explains the methods of depiction.

Smooth lines enclose areas of forecast IFR weather and scalloped lines enclose areas of marginal weather (MVFR). VFR areas are not outlined. This in not the same manner of depiction used on the Weather Depiction Chart to portray IFR and MVFR. Referring to Figure 8-1, at 00Z, an area of IFR conditions is depicted portions of Arkansas, Tennessee, Mississippi, and Alabama and is surrounded by an area of MVFR. Notice that the depiction does not extend over the Gulf even though IFR conditions may exist there.

Other areas of MVFR conditions are forecast over the western U.S. and MVFR and IFR conditions are forecast from the Great Lakes region across Canada into the New England area.

Forecast areas of non-convective turbulence of moderate or greater intensity are enclosed by long, dashed lines. Since thunderstorms *always* imply moderate or greater turbulence, areas of thunderstorm related turbulence will not be outlined.

A symbol entered within a general area of forecast turbulence denotes intensity. Numbers below and/or above a short line show expected base and/or top of the turbulent layer in hundreds of feet MSL. Absence of a number below the line indicates turbulence from the surface upward. No number above the line indicates turbulence extending above the upper limit of the chart. Turbulence forecast from the surface to above 24,000 feet MSL is denoted by the notation "SFC" below the line and no entry above the line. Referring to Figure 8-1, at 00Z, an area of moderate nonthunderstorm related turbulence is forecast from the surface to 14,000 feet MSL over most of California and stretching eastward across Arizona, into Colorado and New Mexico. Within this area, a smaller area of moderate to severe turbulence is expected from the surface to 24,000 feet MSL along and near the central and southern California coastline. Other areas of nonthunderstorm related turbulence are forecast over the southeastern and northeastern U.S. Thunderstorm related turbulence is indicated on the lower panels by the forecast areas of thunderstorms.

Freezing level height contours for the *highest* freezing level are drawn at 4,000-foot intervals. The 4,000-foot contour terminates at the 4,000-foot terrain level along the Rocky Mountains. Contours are labeled in hundreds of feet MSL. The zig-zag line where the freezing level is forecast to be at the surface and is labeled "SFC." An upper freezing level contour crossing the surface/32 degree line indicates multiple freezing levels. Multiple freezing levels indicate layers of warmer air aloft. If clouds and precipitation are forecast in this area, icing hazards should be considered.

The low-level significant weather prog does not specifically outline areas of icing. However, icing is implied in clouds and precipitation above the freezing level. Interpolate for freezing levels between the given contours. For example, in Figure 8-1 at 00Z, the forecast *highest* freezing level over St. Louis is approximately 6,000 feet MSL.

36- and 48-Hour Surface Weather Prog

This prog is an extension of the 12- and 24-hour surface prog and is based on the 00Z and 12Z initial synoptic data. The prog in Figure 8-2 is a continuation of the 12- and 24-hour prog in Figure 8-1.

The depiction of data is about the same as the 12-

and 24-hour surface prog with the following exceptions.

1. Freezing precipitation is not forecast.
2. Scalloped lines denote areas of *overcast* clouds with *no* reference to the height of the cloud base.
3. A prognostic discussion is included to explain the forecaster's reasoning for the 12- through 48-hour surface progs.

Use of the Chart

The 36- and 48-hour surface prog should only be used for outlook purposes. That is, just to get a very general picture of the weather conditions that are in the relatively distant future.

HIGH LEVEL SIGNIFICANT WEATHER PROG

The High-Level Significant Weather Prog is derived from forecasts for both domestic and international flights. The U.S. National Meteorological Center (NMC), near Washington D.C., is a component of the World Area Forecast System (WAFS). NMC is designated in the WAFS as both a World Area Forecast Center and a Regional Area Forecast Center (RAFC). The main function of the NMC as a WAFS, is to prepare global forecasts in grid-point form of upper winds and upper air temperatures and to supply the forecasts to associated RAFCs. An important RAFC function is to supply users with forecast winds and temperatures aloft along with significant weather forecast charts.

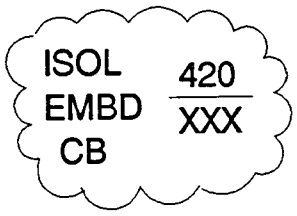
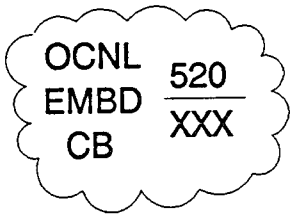
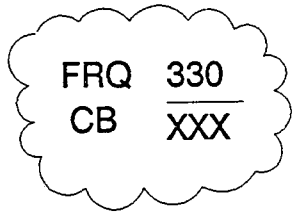
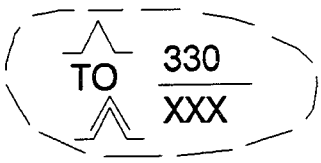
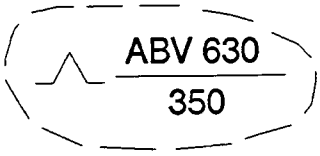
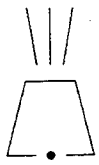
The High-Level Significant Weather Prog, Figure 8-3, encompasses airspace from 25,000 feet to 60,000 feet pressure altitude over the conterminous U.S., Mexico, Central America, portions of South America, the western Atlantic, and eastern Pacific. This section discusses the content of high-level significant weather progs.

The following weather is depicted on the charts:

a. active thunderstorms
b. severe squall lines
c. tropical cyclone(s)
d. from 10,000 feet MSL to flight level 250, clouds associated with a) thru c) above
e. above flight level 250, cumulonimbus cloud associated with a) to c) above
f. moderate or severe turbulence (in cloud or clear air)
g. moderate or severe icing
h. widespread sandstorm/duststorm(s)
i. surface positions of well-defined convergence zones
j. surface positions, speed and direction of movement of frontal systems
k. tropopause heights
l. jetstreams
m. volcanic activity, including the name of the volcano, latitude and longitude, the date and time of the first eruption, and a reminder to check any SIGMETs for further information.

Table 8-3 gives some examples of notations appearing on a High Level Significant Weather Prog chart.

Table 8-3. Depiction of clouds, turbulence, and volcanic activity on a High Level Significant Weather Prog

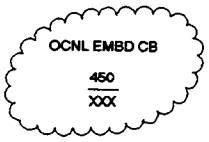
Depiction	*Meaning*
	Embedded cumulonimbus, less than 1/8 coverage, bases below 24,000 feet, tops 42,000 feet
	Embedded cumulonimbus, 1/8 to 4/8 coverage, bases below 24,000 feet, tops 52,000 feet
	Cumulonimbus, 5/8 to 8/8 coverage, bases below 24,000 feet, tops 33,000 feet
	Moderate to severe turbulence, below 24,000 feet to 33,000 feet (for turbulence below 24,000 feet see low-level prog)
	Moderate turbulence from 35,000 feet to above upper limit of the prog
	Volcanic Eruption Mt. Spurr 61.3 N 152.3 W At 15/1325Z CHECK SIGMETS FOR VOLCANIC ASH

Thunderstorms - The abbreviation or symbol "CB", is used to depict required thunderstorm activity. By definition, this symbol refers to either the occurrence or expected occurrence of an area of widespread cumulonimbus clouds along a line with little or no space between individual clouds or cumulonimbus clouds embedded in cloud layers or concealed by haze or dust. It does not refer to isolated or scattered (occasional) cumulonimbus clouds that are not embedded in cloud layers or concealed by haze or dust. The symbol "CB" automatically implies moderate or greater turbulence and icing and these conditions are not depicted separately.

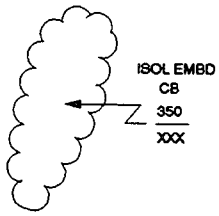
CB data will normally be identified as ISOL EMBD CB (isolated embedded CB), OCNL EMBD CB (occasional embedded CB), ISOL CB in HAZE (isolated CB in haze), or OCNL CB in HAZE (occasional CB in haze). In rare instances, CB coverage above FL240 may exceed 4/8 coverage; in these instances, CB activity will be described as FRQ CB (frequent cumulonimbus with little or no separation). The meanings of these area coverage terms are: ISOL (less than 1/8), OCNL (1/8 to 4/8) and FRQ (5/8 to 8/8).

CB bases below FL240 are shown as XXX. CB tops are expressed in hundreds of feet MSL. The area the forecast applies to is enclosed by scalloped lines.

For example:

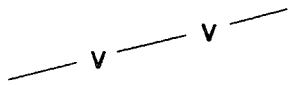


Occasional (1/8 to 4/8 area coverage) embedded cumulonimbus clouds with bases below FL240 and tops forecast to reach FL450.

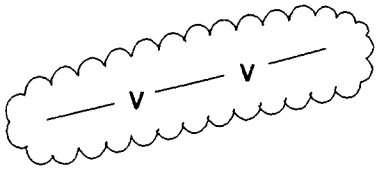


Isolated (less than 1/8 area coverage) embedded cumulonimbus clouds with bases below FL240 and tops forecast to reach FL350.

Squall Lines - Severe squall lines are lines of CB's of 5/8's coverage or greater and pose a significant hazard to aviation. A squall line is depicted as shown below.



Severe squall lines are depicted within areas of CB activity by this symbol.

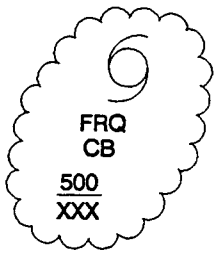


An example of a severe squall line and the associated CB area.

The example above shows a forecast severe squall line with associated CBs. Coverage 5/8 to 8/8 with bases below FL240 and top forecast to reach FL500.

Tropical Storms - the symbol to the left depicts tropical storms. Areas of associated cumulonimbus activity, if meeting the previously given criteria (ISOL EMBD CB, OCNL EMBD CB, ISOL CB IN HAZE, OCNL CB IN HAZE, FRQ CB), are enclosed by scalloped lines and labeled with the vertical extent.

For example:



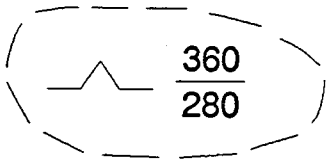
A thunderstorm area (5/8 to 8/8 area coverage, bases below FL240, tops FL500) associated with a tropical cyclone.

Notes:

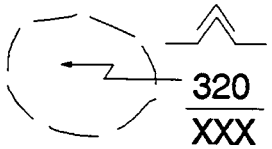
1. The names of tropical cyclones, when relevant, are entered adjacent to the symbol.
2. A significant weather chart depicting the tropical cyclone symbol will state that the latest tropical cyclone advisory, rather than the tropical cyclone's forecast position on the chart, is to be given public dissemination.

Turbulence - Areas of forecast moderate or greater clear air turbulence (CAT) are bounded by heavy, dashed lines. Clear air turbulence includes all turbulence (wind shear induced and mountain wave induced) not caused by convective activity. Areas are labeled with appropriate turbulence symbol (Table 8-1) and the vertical extent in hundreds of feet MSL.

For example:



An area of forecast moderate CAT with vertical extent from FL280 to FL360.

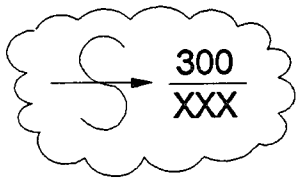


An area of forecast severe CAT with vertical extent from FL240 to FL320.

Note: *The symbol CB implies hail, moderate or greater turbulence, and icing.*

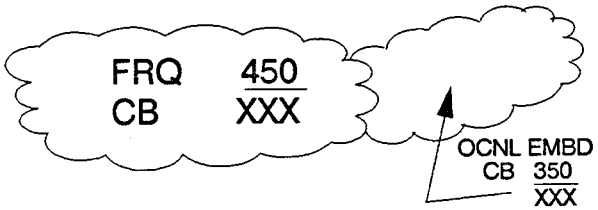
Sand/Duststorms - Areas of widespread sandstorms (BN) and duststorms (BD) are enclosed by scalloped lines and labeled by symbol and vertical extent.

For example:



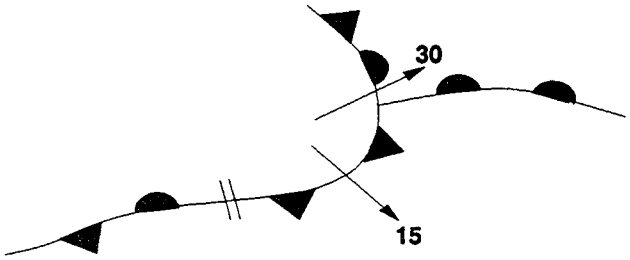
Widespread sandstorm or dust-storm with bases below FL240 (at the surface) and tops forecast to reach FL300.

Convergence Zones - Convergence zones are areas of active thunderstorm activity. These zones are enclosed by scalloped lines and labeled with the vertical extent of the CBs. Note that the CBs must meet the previous given criteria (ISOL EMBD CB, OCNL EMBD CB, ISOL CB IN HAZE OCNL CB IN HAZE, FRQ CB).
For example:



The forecast position of the inter-tropical convergence zone is shown by the associated thunderstorm areas. The coverage for the frequent CBs is 5/8 to 8/8 with bases below FL240 with tops at FL450. The coverage for the occasional CBs is 1/8 to 4/8 with bases below FL240 and tops at FL350.

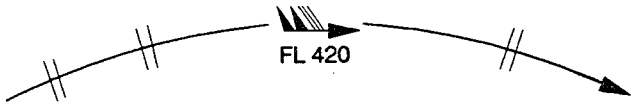
Fronts - The forecast surface positions, speed, and direction of movement of frontal systems associated with significant weather are also depicted.
For example:



A frontal system is forecast to be at the position and with the orientation indicated at the valid time of the prognostic chart. The forecast movement related to true north and speed in knots are indicated by arrow shafts and adjacent numbers.

Tropopause Heights - Tropopause heights are depicted in hundreds of feet MSL. The five sided polygon, on the left, indicates areas of high and low tropopause heights. This particular example shows a low tropopause height of 22,000 feet MSL. Other heights may be used occasionally to define areas of very flat tropopause slope. Depicted heights are enclosed in small rectangular blocks. For example, Figure 8-3 shows the tropopause sloping from 30,000 feet in North Dakota to 39,000 feet in Oklahoma.

Jet Streams - The height and maximum wind speed of jet streams having a core speed of 80 knots or greater are shown. The height is given as a flight level (FL). The beginning of the line shows a core speed of 80 knots. A double, hatched line across the jet stream core indicates a speed increase or decrease. The double, hatched line indicates 20 knot changes at 100 knots, 120 knots, 140 knots or higher. The maximum core speed along the jet stream is depicted by shafts, pennants, and feathers.
For example:



A jet stream with a forecast maximum speed of 130 knots at a height of 42,000 feet MSL. The extreme left line starts at 80 knots. The first hatched, double line indicates a speed increase of 20 knots to 100 knots and the second double-hatched line shows an increase of 20 knots to 120 knots. The double-hatched line to the right of the maximum speed indicates a decrease of 20 knots to 120 knots. Wind directions are indicated by the orientation of arrow shafts in relation to true north.

Volcanic Activity - Volcanic activity is indicated by a trapezoidal figure as depicted to the left. The symbol designates the location of volcanic activity on the High Level Significant Weather Charts. The "." at the base of the symbol will be located at the latitude/longitude of the volcano. The symbol and any known information concerning the name of the volcano, latitude and longitude, the date and time of the first eruption, and a reminder to check any SIGMETs for further information will be included in the legend of the chart. An example of the information which is to be included in the chart's legend is provided in Table 8-3.

INTERNATIONAL FLIGHTS

Figure 8-4 is an example of the High Level Significant Weather prog chart for international flights between the U.S. and Europe and northern Africa. It basically has the same information and notation as the domestic High Level Significant Weather prog. It is for flights

between 25,000 feet and 60,000 feet pressure altitude and is on a polar map projection. Referring to Figure 8-4, the legend shows NMC as a Regional Area Forecast Center (RAFC) and the originator of this significant weather prog. The valid time of this particular prog is 18Z on March 25, 1994.

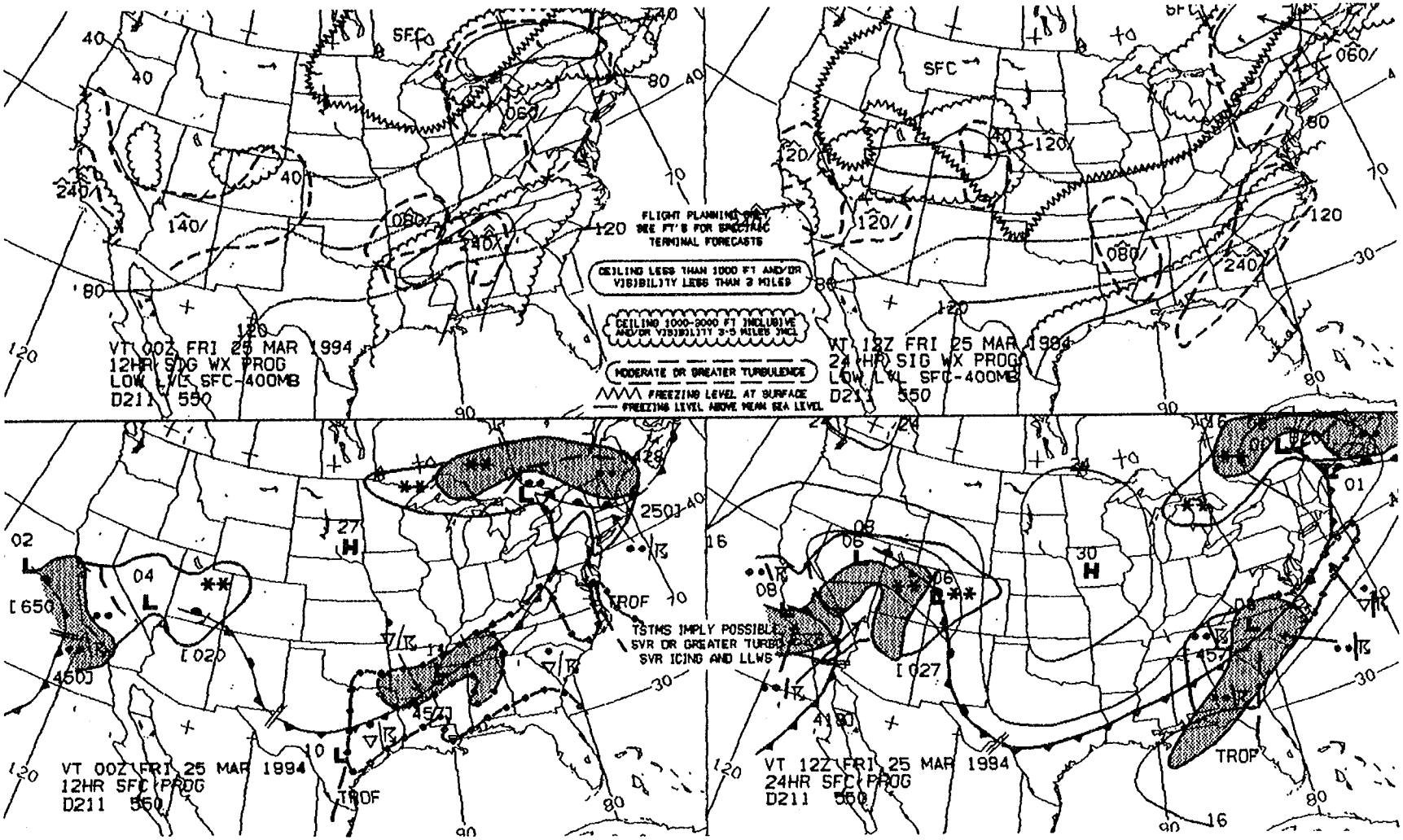
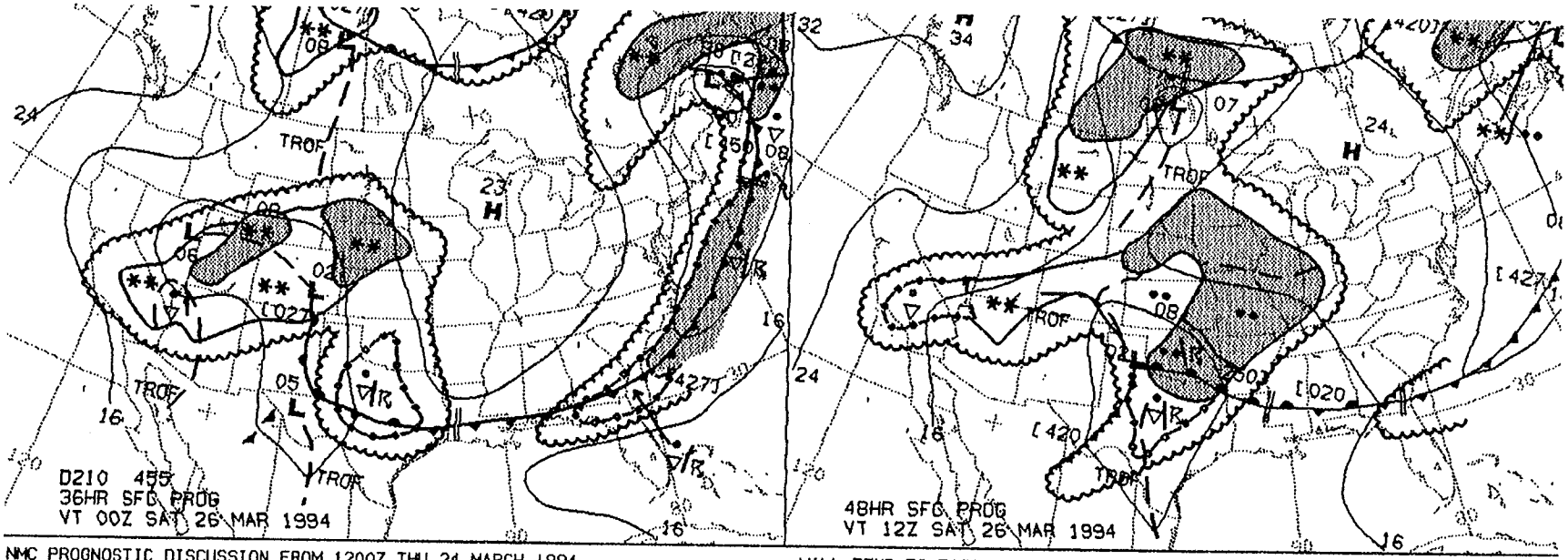


FIGURE 8-1. U.S. Low-Level Significant Weather Prog



NMC PROGNOSTIC DISCUSSION FROM 1200Z THU 24 MARCH 1994
METEOROLOGICAL OPERATIONS DIVISION, NMC, NWS, WASHINGTON, DC
REF 12 TO 48 HRS MANUAL GRAPHICS

A VERY WET PATTERN WILL BE SHAPING UP ACRS THE NATION AS PORTION OF DEEP UPPER LOW OFF THE COAST OF CA MOVES INLAND DURG THE PD. WHILE THE NGM HAS TRENDED TOWARD THE SLOWER AVN/ETA SOLNS WITH THE HANDLING OF THIS SYSTEM IT STILL IS THE FASTER OF THE MODELS IN TAKING A SIGNIFICANT PIECE OF S/WV ENERGY INTO THE CNTL HI PLAINS BY 48 HRS. THIS HAS BIG IMPLIFICATIONS AS FAR AS PSBL PHASING WITH AMPLIFYING NRN STREAM THRU SCNTL CANADA AS WELL AS THE TRACK OF DVLPG SFC LOW IN THE PLAINS. GIVEN RECENT HISTORY OF NGM..FEEL IT IS MUCH TOO QUICK AND WILL GENLY LEAN TOWARD SLOWER AVN/ETA SOLNS WHICH HAVE BEEN MORE CONSISTENT. IN ADDITION..FEEL THE MORE SRN LEE LOW DVLPMENT ACRS SE CO TOWARD THE TX PANHANDLE IN THE 36 TO 48 HR PD IS IN BETTER RELATION TO THE UPPER JET. OTHERWISE..STG VORT MAX SEEN ON SW SIDE OF UPPER LOW WILL BEGIN TO ACCELERATE ACRS SRN CA BY 24 HRS AS JET MAX ROUNDS THE BASE OF THE UPPER TROF. TILL THEN..THE MORE SIGNIFICANT RAINS WILL TEND TO EASE SLOWLY EWD FROM THE COASTAL REGIONS OF CNTL/SRN CA WITH LIGHTER PCPN AMOUNTS..MAINLY AS SNOW..EXPANDING E OF THE SIERRAS THRU THE GT BASIN AND CNTL ROCKIES AS MOIST SW FLOW ALOFT INCREASES. ON DAY 2..MAIN PCPN FOCUS WILL JUMP TOWARD THE PLAINS AS LOW PRESSURE BEGINS TO ORGANIZE OVER THE SRN HI PLAINS. THE FLATTER/SLOWER SOLN OF ETA/AVN WOULD SUGGEST GENLY LIGHT SNOWS STREAKING OUT OVER THE COLDER CNTL/NRN PLAINS ASSOCD WITH THE UPPER JET..WHILE HEAVIER CONVECTIVE RAINS INCREASE ALONG AND N OF E/W FRONT VCNTY THE RED RIVER VALLEY RGN. IN THE EAST..PREFER THE FASTER AVN/NGM SOLNS WITH REGARD TO SFC WAVE TRACKING EWD ALONG COLO FRONT DAY 1 WHICH ARE IN A BETTER RELATIONSHIP TO THEIR RESPECTIVE 5H S/WV FCSTS AND THERMAL PATTERN THAN THE ETA. THIS WOULD SUGGEST MDT TO LOCALLY HEAVY RAIN/TSTMS WILL SPREAD RAPIDLY ACRS THE TN VALLEY INTO THE CAROLINAS AND SE STATES BY EARLY FRI MRNG WITH PCPN ENDING MOST AREAS BY FRI EVE. COOLER CONDS WILL SPREAD ACRS THE GT LAKES RGN INTO THE NE FOLLOWING FROPA AS WEAK HI PRESSURE SINKS SEWD FROM THE DAKOTAS. SULLIVAN/WEATHER FORECAST BRANCH

FIGURE 8-2. U.S. Low-Level 36- and 48-hour Significant Weather Prog

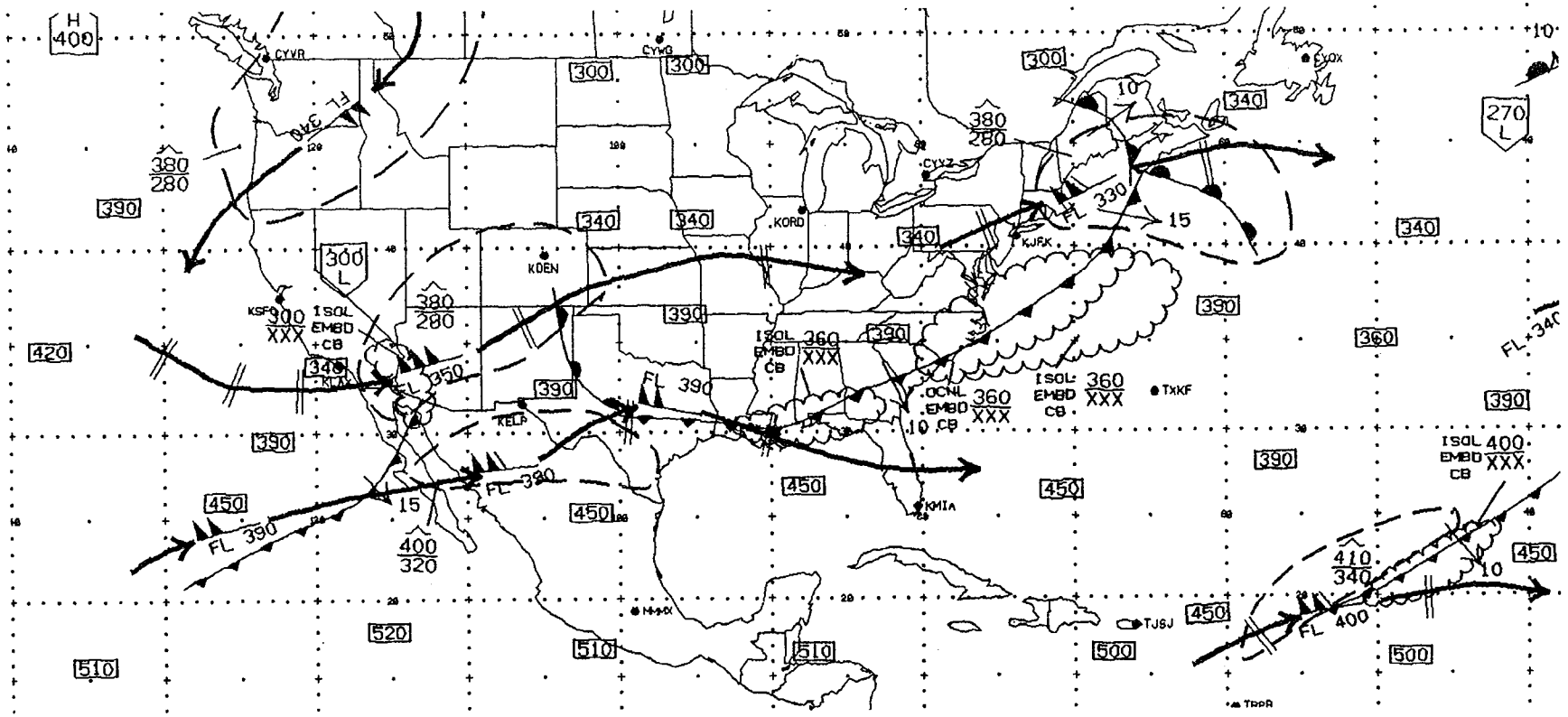


FIGURE 8-3. U.S. High-Level Significant Weather Prog

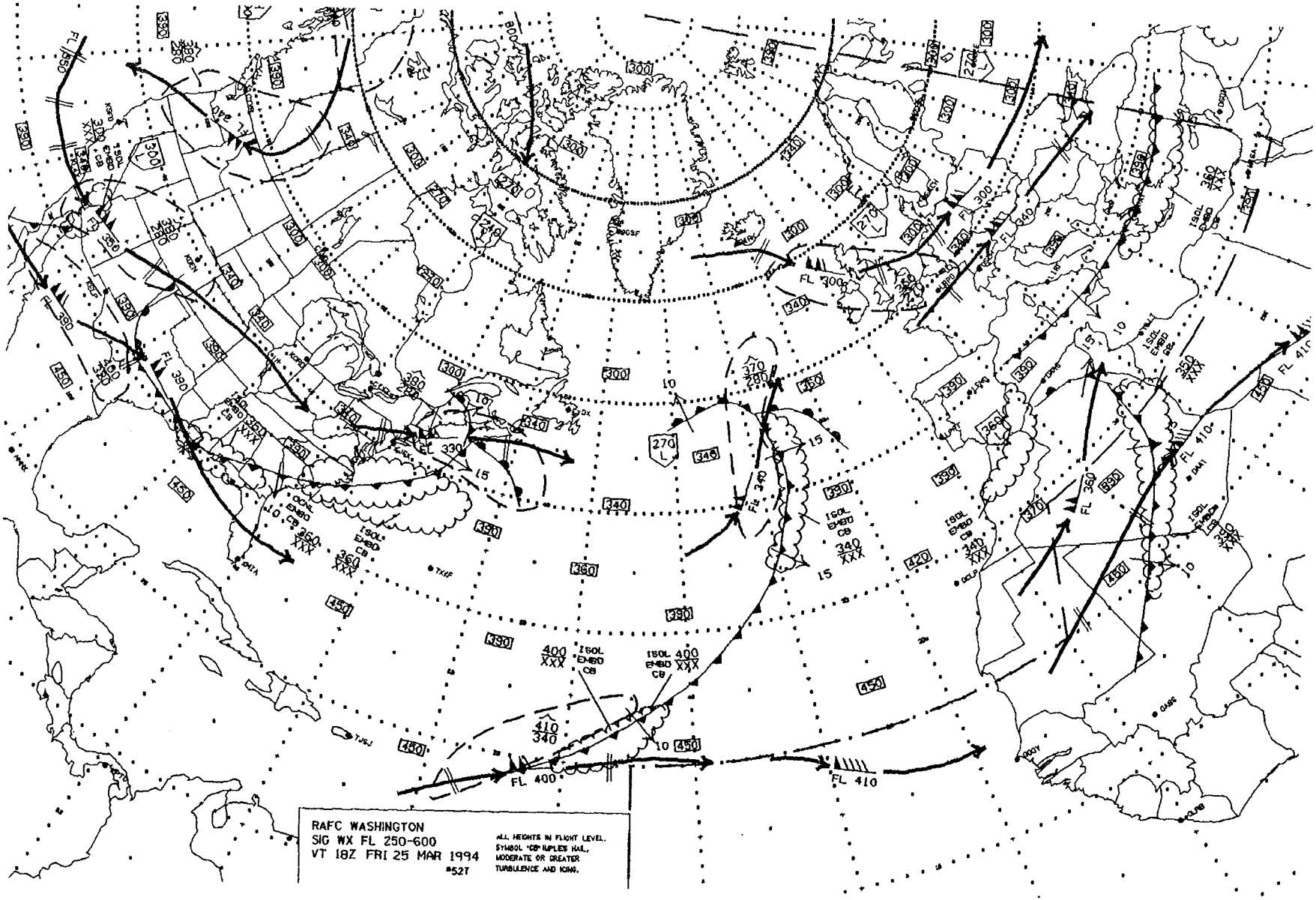


FIGURE 8-4. International High-Level Significant Weather Prog

Section 9

WINDS AND TEMPERATURES ALOFT CHARTS

Winds aloft, both forecast and observed, are a computer-generated product. The forecast winds aloft charts also contain forecast temperatures aloft.

FORECAST WINDS AND TEMPERATURES ALOFT (FD)

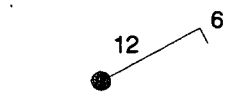
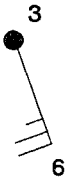
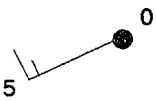
Forecast winds and temperatures aloft are prepared for eight levels on eight separate panels. The levels are 6,000; 9,000; 12,000; 18,000; 24,000; 30,000; 34,000 and 39,000 feet MSL. They are available daily as 12 hour progs valid at 1200Z and 0000Z. A legend on each panel shows the valid time and the level of the panel. Levels below 18,000 feet are in true altitude and levels 18,000 feet and above are in pressure altitude. Figure 9-1 is examples from a winds and temperatures aloft forecast chart.

Temperature is in whole degrees Celsius for each forecast point and is entered above and to the right of the station circle. Arrows with pennants and barbs, similar to those used on the surface map, show wind direction and speed. Wind direction is drawn to the nearest 10 degrees with the second digit of the coded direction entered at the outer end of the arrow. To determine wind direction, obtain the general direction from the arrow and then use the digit to determine the direction to the nearest 10 degrees. For example, a wind in the northwest quadrant with a digit of "3," indicates 330 degrees. A calm or light and variable wind is shown by "99" entered to the lower left of the station circle. See Table 9-1 for examples of plotted temperatures and winds with their interpretations.

OBSERVED WINDS ALOFT

Charts of observed winds for selected levels are sent twice daily on a four-panel chart valid at 1200Z and 0000Z. Figure 9-2 is an example of this chart and Figure 9-3 is an example of one of the panels. Wind direction and speed is shown by arrows, the same as on the forecast charts. A calm or light and variable wind is shown as "LV" and a missing wind as "M," both plotted to the lower right of the station circle. The station circle is filled in when the reported temperature/dew point spread is 5 degrees Celsius or less. Observed temperatures are included on the upper two panels of this chart (24,000 feet and 34,000 feet). A dotted bracket around the temperature means a calculated temperature.

TABLE 9-1. Plotted winds and temperatures.

Plotted	Interpretation
	12 degrees Celsius, wind 060 degrees at 5 knots
	3 degrees Celsius, wind 160 degrees at 25 knots
	0 degrees Celsius, wind 250 degrees at 15 knots
	-9 degrees Celsius, wind 260 degrees at 50 knots
	-47 degrees Celsius, wind 360 degrees at 115 knots
	-11 degrees Celsius, wind calm or light and variable

The second standard level for a reporting station is found between 1,000 and 2,000 feet above the surface, depending on the station elevation. To compute the second standard level, find the next thousand feet level above the station elevation and add 1,000 feet to that level. For example, the next thousand foot level above Oklahoma City, OK (station elevation 1,290 feet MSL) is 2,000 feet MSL. The second standard level for Oklahoma City, OK (2,000 feet + 1,000 feet) is 3,000 feet MSL or 1,710 feet AGL.

For example:

Station	Amarillo TX	Bismarck ND	Topeka KS	Key West FL
Station elevation:	3604 MSL	1677 MSL	879 MSL	0 MSL
Next thousand foot level above station:	4000 MSL +1000	2000 MSL +1000	1000 MSL +1000	1000 MSL +1000
Second standard level:	5000 MSL or 1396 AGL	3000 MSL or 1323 AGL	2000 MSL or 1121 AGL	2000 MSL or 2000 AGL

Note that the 14,000 feet MSL panel is true altitude while the 24,000 and 34,000 feet MSL panels are in pressure altitude.

USING THE CHARTS

The use of the winds aloft chart is to determine winds at a proposed flight altitude or to select the best altitude for a proposed flight. Temperatures also can be determined from the forecast charts. Interpolation must be used to determine winds and temperatures at a level between charts and data when the time period is other than the valid time of the chart.

Forecast winds are generally preferable to observed winds since they are more relevant to flight time. Although observed winds are 5 to 8 hours old when received, they still can be a useful reference to check for gross errors on the 12-hour prog.

INTERNATIONAL FLIGHTS

Computer-generated forecast charts of winds and temperatures aloft are available for international flights at specified levels. The U.S. National Meteorological Center (NMC), near Washington D.C., is a component of the World Area Forecast System (WAFS). NMC is designated in the WAFS as both a World Area Forecast Center and a Regional Area Forecast Center (RAFC). Its main function as a World Area Forecast Center is to prepare global forecasts in grid-point form of upper winds and upper air temperatures and to supply the forecasts to associated RAFCs. One of NMC's main RAFC functions is to prepare and supply to users charts of forecast winds, temperatures, and significant weather.

For example, Figures 9-4 and 9-5, are originated by NMC. The flight level of Figure 9-4 is 34,000 feet MSL and Figure 9-5 is 45,000 feet MSL. This along with the valid time of the chart, and the data base time (data from which the forecast was derived) make up the legend along an edge of each chart.

Forecast winds are expressed in knots for spot locations with direction and speed depicted in the same manner as the U.S. forecast winds and temperatures aloft chart (Figure 9-1). Forecast temperatures are depicted for spot locations inside circles which are expressed in degrees Celsius. For charts with flight levels at or below FL180 (18,000 feet), temperatures are depicted as negative (-) or positive (+). On charts for flight levels (FL) above FL180, temperatures are always negative and no sign is depicted.

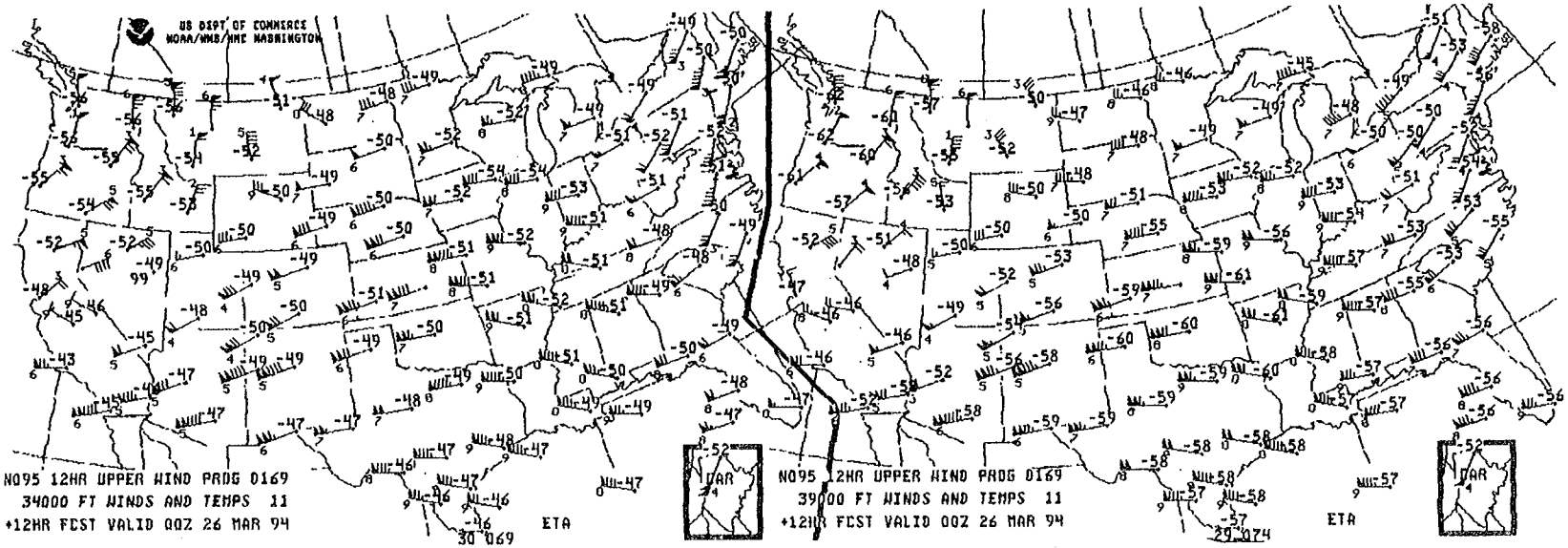


FIGURE 9-1. Panels of Forecast Winds and Temperatures Aloft

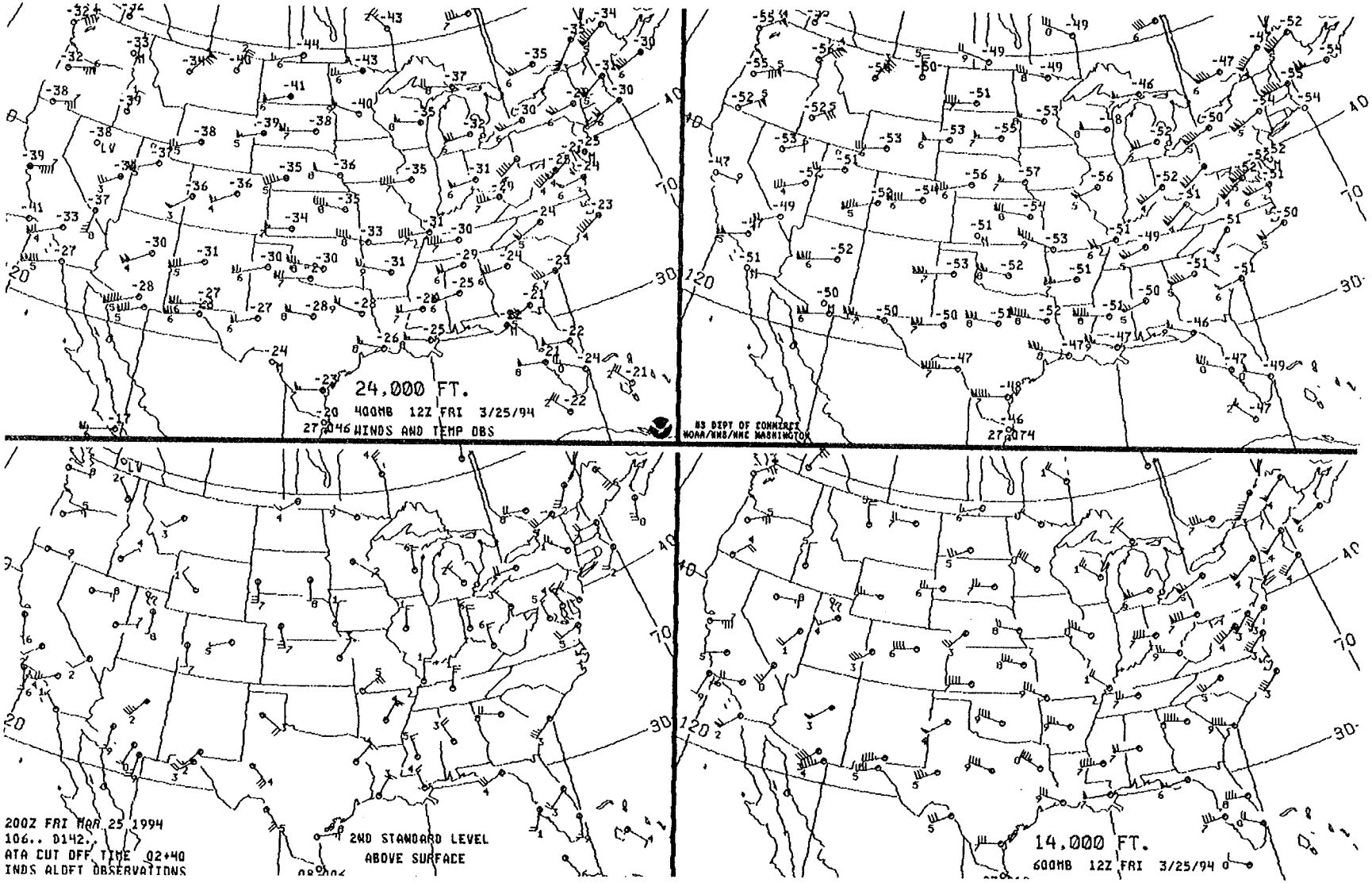


FIGURE 9-2. An Observed Winds and Temperatures Aloft Chart

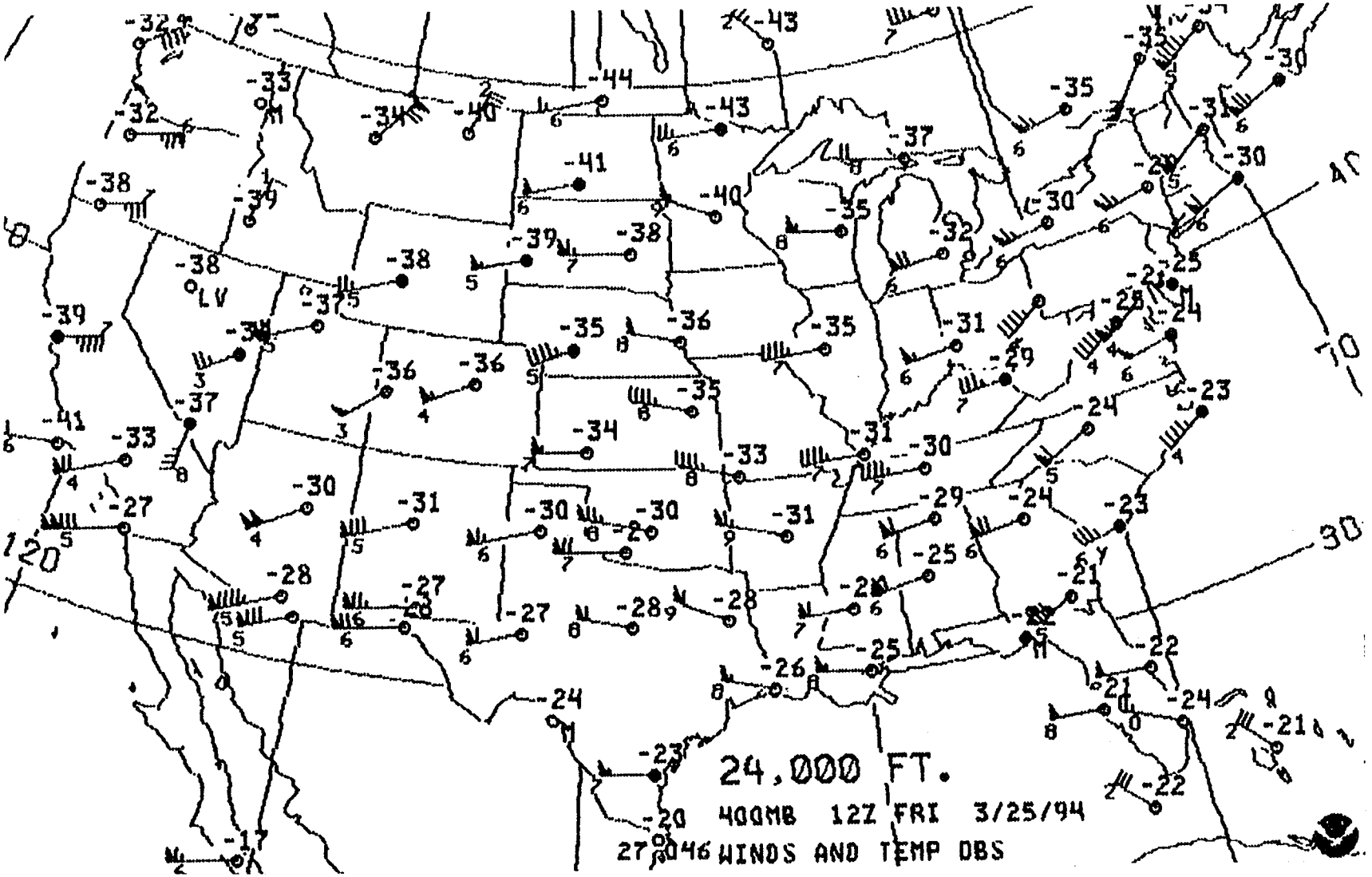


FIGURE 9-3. A Panel of Observed Winds and Temperatures for 24,000 Feet

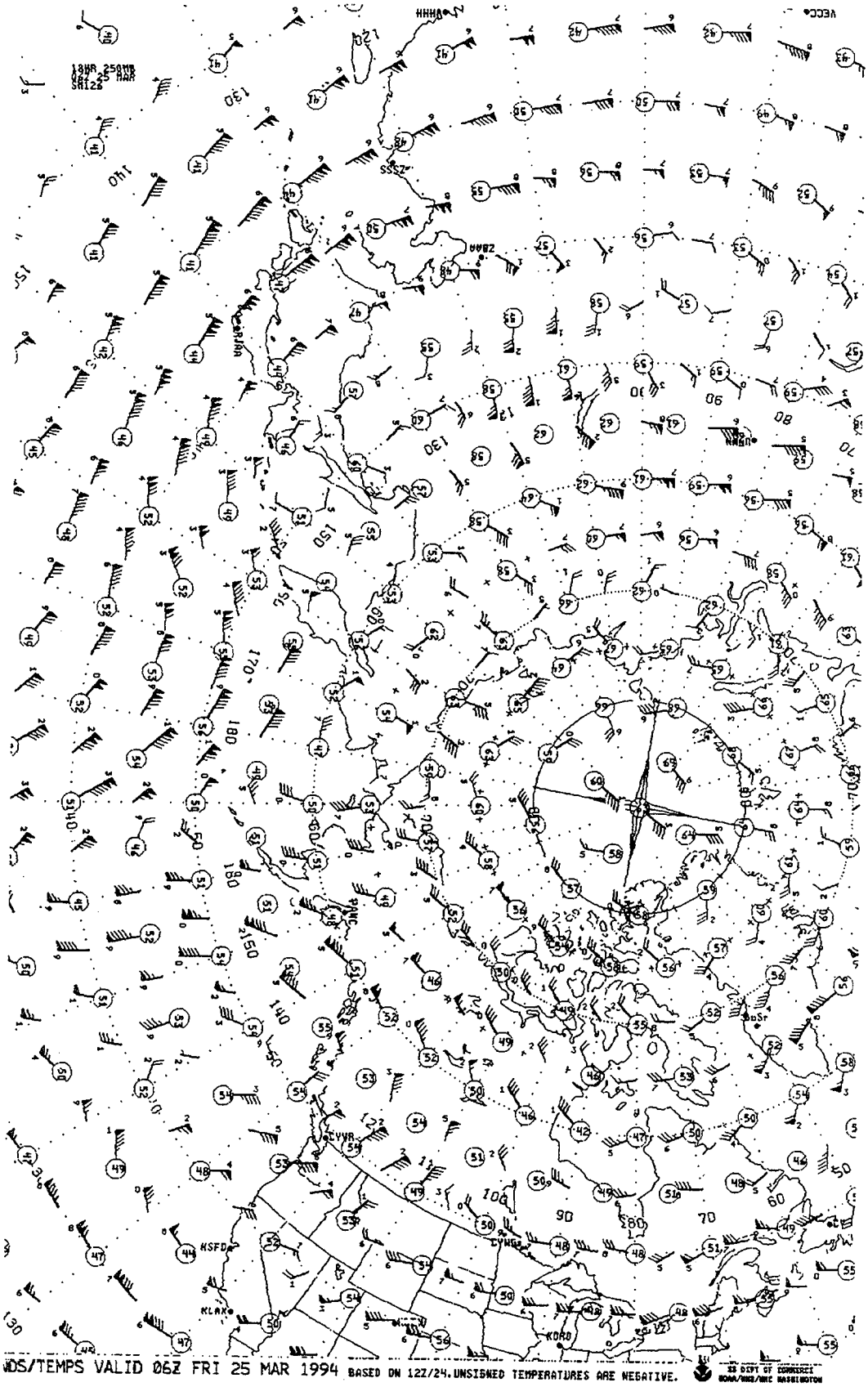


FIGURE 9-4. A Polar Stereographic Forecast Winds and Temperatures Aloft Chart

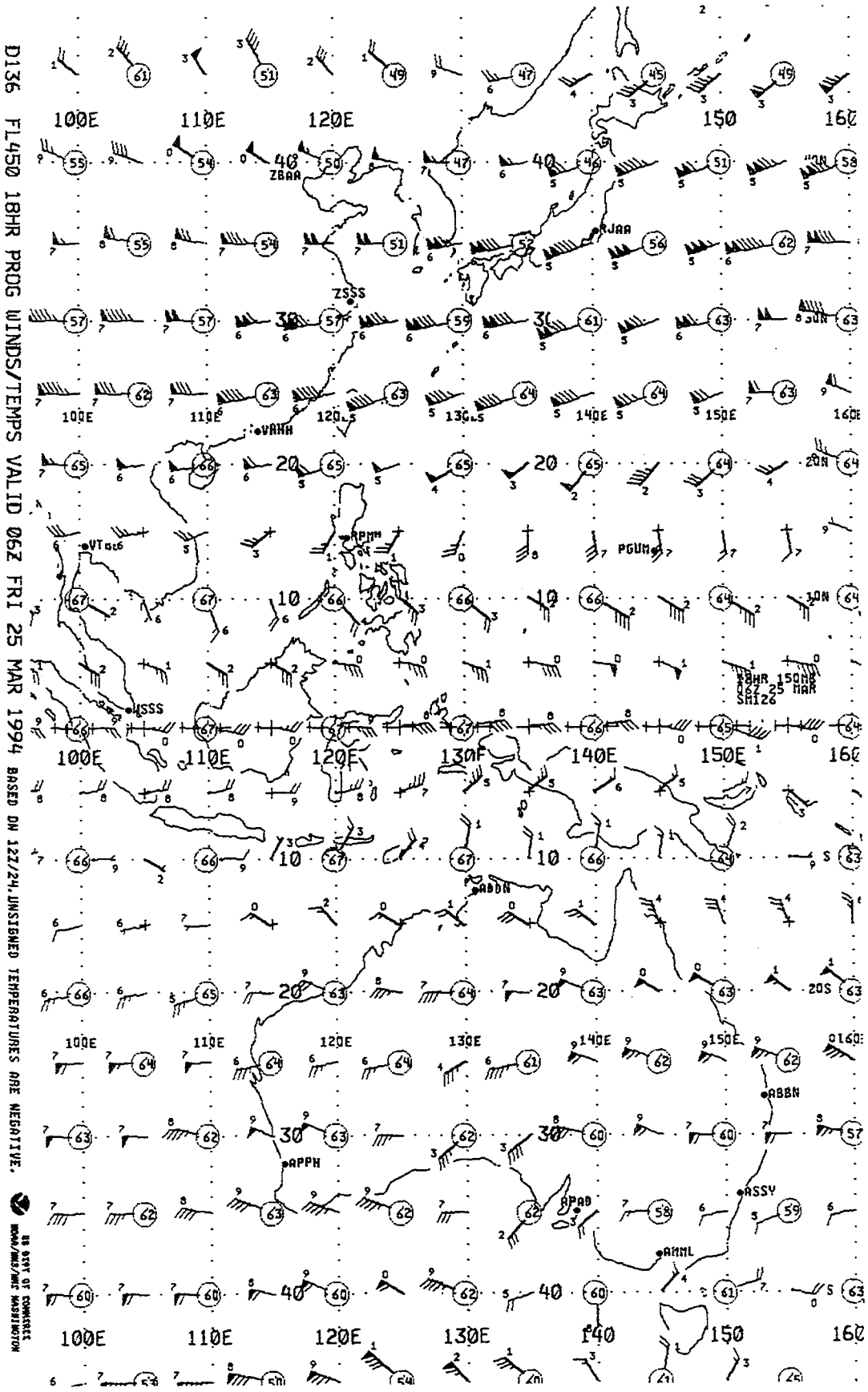


FIGURE 9-5. A Mercator Forecast Winds and Temperatures Aloft Chart

Section 10

COMPOSITE MOISTURE STABILITY CHART

The composite moisture stability chart (Figure 10-1), is an analysis chart using observed upper air data. The chart is composed of four panels including stability, freezing level, precipitable water and, average relative humidity. This computer-generated chart is available twice daily with valid times of 12Z and 00Z. The availability of upper air data (on all the panels) for analysis is indicated by the shape of the station model. Use the legend on the precipitable water panel of Figure 10-4 for the explanation. On this chart, the mandatory levels used are the surface, the 1000 mb/hPa, the 850 mb/hPa, the 700 mb/hPa, and the 500 mb/hPa. Significant levels are the levels where significant changes in temperature and/or moisture occur when compared to below or above that level.

STABILITY PANEL

The stability panel, the upper left panel of the chart, outlines areas of stable and unstable air. Figure 10-2 shows the two stability indices that are computed for each upper air station. The top value is the *lifted index* and is plotted above a short line, below the line is the *K index*. An "M" indicates the value is missing.

Lifted Index (LI)

The lifted index is computed as if a parcel of air near the surface were lifted to 500 millibars/hectoPascals (18,000 feet MSL). As the air is "lifted" it cools, at 3 degrees Celsius per 1,000 feet, due to expansion. The temperature the parcel would have at 500 millibars is then subtracted from the actual (environmental) 500 millibar/hectoPascal temperature. This difference is the lifted index which is positive, negative or zero and indicates the stability of the parcel of air.

A positive index means that a parcel of air, *if lifted*, would be colder than the surrounding air at 500 millibars/hectoPascal. The air is, therefore, stable and would resist vertical motion. Large positive values (+8) would indicate very stable air.

A negative index means that the low-level air, *if lifted* to 500 millibars/hectoPascals, would be warmer than the surrounding air. The air is unstable and suggests the possibility of convection. Large negative values (-4 or less) would indicate very unstable air.

A zero index means that the parcel of air, *if lifted* to 500 millibars/hectoPascals, would have the same temperature as the actual air at 500 millibars/hectoPascals. This air is said to be neutrally stable (neither stable or unstable).

When using this chart, remember that the lifted index assumes the air near the surface will be lifted to 500 millibars/hectoPascals. Whether or not the air near the surface will be lifted to 500 millibars/hectoPascals depends on what is happening below. It is possible to have a negative LI with no thunderstorm development because either the air below 500 mb/hPa is not being lifted high enough or there is not enough moisture in the air. For use, the lifted index is more indicative of the severity of the thunderstorms, if they occur, rather than the probability of general thunderstorm occurrence (Table 10-1). Also note that the LI can change dramatically just by daytime heating and nighttime cooling. Daytime heating tends to make the LI value less positive (more unstable) and nighttime cooling tends to make the LI more positive (more stable).

K Index

The K index is primarily for the meteorologist. It examines the temperature and moisture profile of the environment. The K index is not really a stability index because the parcel of air is not lifted and compared to the environment. The K index is computed using three terms:

K = (850 mb/hPa temp - 500 mb/hPa temp)
+ (850 mb/hPa dew point)
- (700 mb/hPa temp/dew point spread)

The first term (850 mb/hPa temp - 500 mb/hPa temp) compares the temperature at about 5,000 feet MSL to the temperature at about 18,000 feet MSL. The larger a temperature difference, the more unstable the air and the higher the K value.

The second term (850 mb/hPa dew point) is a measure of low-level moisture. Note that since the dew point is added to the value, high moisture content at 850 mb/hPa increases the K value.

The third term (700 mb/hPa temp/dew point spread) is a measure of saturation at 700 mb/hPa. The greater the spread, the drier the air; and since the term is subtracted, it lowers the K value. The greater the degree of saturation at 700 millibars/hectoPascals, the larger

the K value.

During the thunderstorm season, a large K index indicates conditions favorable for air mass thunderstorms (Table 10-1). However, K index values and meanings can decrease significantly for thunderstorm development associated with a synoptic scale low pressure system (non air-mass thunderstorms).

In winter, because of cold temperatures and low moisture values, the temperature terms completely dominate the K value computation. Because of the lack of moisture, even fairly large values do not mean conditions are favorable for thunderstorms. Be aware that the K values can change significantly over a short time period due to temperature and moisture advection.

TABLE 10-1. Thunderstorm Potential

LIFTED INDEX (LI)	SEVERE POTENTIAL	"K" * INDEX	AIRMASS THUNDERSTORM PROBABILITY
0 to -2	Weak	<15	near 0%
		15-20	20%
-3 to -5	Moderate	21-25	21-40%
		26-30	41-60%
≤ -6	Strong	31-35	61-80%
		36-40	81-90%
		>40	near 100%

It is essential to note that an unstable Lifted Index does NOT automatically mean thunderstorms. Look at the synoptic situation and if thunderstorms are expected to develop in the unstable air, Table 10-1 may be used in accordance with this section.

* Use caution when applying these values in the western mountainous terrain due to elevation.

Stability Analysis

The analysis is based on the lifted index only. Station circles are blackened for LI values of zero or less. Solid lines are drawn for values of +4 and less at intervals of 4 (+4, 0, -4, -8, etc).

Using the Panels

When clouds and precipitation are forecast or are occurring, the stability index is used to determine the type of clouds and precipitation. That is, stratiform clouds and continuous precipitation occur with stable air, while convective clouds and showery precipitation occur with unstable air.

Stability is also very important when considering the type, extent, and intensity of aviation weather hazards. For example, a quick estimate of areas of probable convective turbulence can be made by associating the areas with unstable air. An area of extensive icing would be associated with stratiform clouds and steady precipitation which are characterized by stable air.

FREEZING LEVEL PANEL

The freezing level panel, the lower left panel of the chart, is an analysis of the observed freezing level data from upper air observations (Figure 10-3).

TABLE 10-2. Plotting Freezing Levels

Plotted	Interpretation
○ BF	Entire observation is below freezing (0 degree Celsius)
28 ✳	Freezing level is at 2,800 feet; Temperatures below freezing above 2,800 feet.
120 □	Freezing level at 12,000 feet; Temperatures above 12,000 feet are below freezing.
110 51 ○ BF	Temperatures are below freezing from the surface to 5,100 feet; above freezing from 5,100 to 11,000 feet and below freezing above 11,000 feet.
90 34 ○ 3	Lowest freezing level is at 300 feet; below freezing from 300 feet to 3,400 feet; above freezing from 3,400 to 9,000 feet and below freezing above 9,000 feet (see Table 10-3 for a plot of this sounding).
M ○	Data is missing.

NOTE: The asterisk and the box, instead of a circle, indicate some of the data is missing.
All heights are above Mean Sea Level (MSL).

Analysis

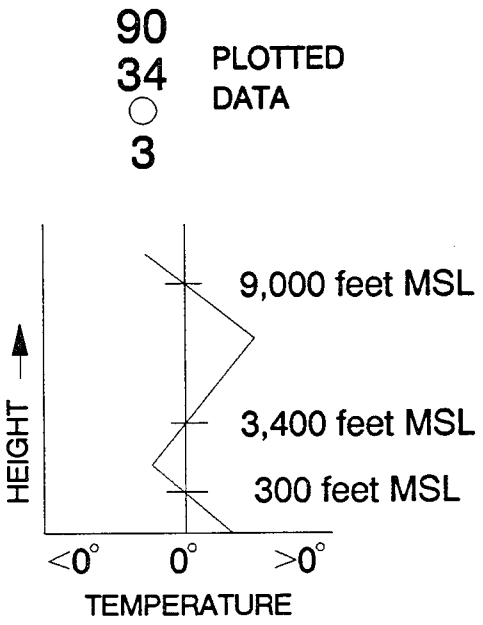
Solid lines are contours of the lowest freezing level and are drawn for 4,000 foot intervals and labeled in hundreds of feet MSL. When a station reports more than one crossing of the zero degree Celsius isotherm, the lowest crossing is used in the analysis. This is in contrast to the low-level significant weather prog on which the depicted forecast freezing level aloft is the highest freezing level. A dashed line represents the 32 degree Fahrenheit isotherm at the surface and will outline an area of stations reporting "BF" (below freezing).

Using the Panel

The contour analysis shows an overall view of the lowest observed freezing level. Always plan for possible icing in clouds or precipitation especially between the temperatures of zero and -10 degrees Celsius.

Plotted multiple crossings of the zero degree Celsius isotherm always show an inversion with warm air above subfreezing temperatures (Table 10-3). This situation can produce very hazardous icing when precipitation is occurring. Airmet ZULU (Section 4) shows more specifically the areas of expected icing. The low-level significant weather prog shows anticipated changes in the freezing level.

TABLE 10-3. Vertical Temperature Profile of Freezing Levels.



This is an example of three crossings of the 0 degree C isotherm.

PRECIPITABLE WATER PANEL

The precipitable water panel, the upper right panel of the chart, is an analysis of the water vapor content from the surface to the 500 mb/hPa level (Figure 10-4). The amount of water vapor observed is shown as precipitation water, which is the amount of liquid precipitation that would result if all the water vapor were condensed.

Plotted Data

At each station, precipitable water values to the nearest hundredth of an inch are plotted above a short line and the percent of normal value for the month below the line. The percent of normal value is the amount of precipitable water actually present compared to what is normally expected. In Figure 10-4, Amarillo, Texas has a plot of ".47/148." This indicates that 47 hundredths of an inch of precipitable water is present which is 148 percent of normal (above normal) for any day during this month. The ".44/90" at Oklahoma City indicates that 445 hundredths of an inch of precipitable water is present which is only 90 percent of normal (below normal) for any day during this month. An "M" plotted above the line indicates missing data as shown at the station in Canada north of Washington. At Huron, SD the percent of normal value is not plotted. This indicates insufficient climatological data to compute this value.

Analysis

Stations with blackened in circles indicate precipitable water values of 1.00 inch or more. Isopleths (lines of equal values) of precipitable water are drawn and labeled for every 0.25 inches with heavier isopleths drawn at 0.50 inch intervals.

Using the Chart

This panel is used to determine water vapor content in the air between surface and 500 mb/hPa (18,000 feet MSL). It is especially useful to meteorologists concerned with flash flood events. By looking at the wind field upstream from a station, one can get an indication of changes that will occur in the moisture content; that is, determine if the air is drying out or increasing in moisture with time.

AVERAGE RELATIVE HUMIDITY PANEL

The average relative humidity panel, the lower right panel of the chart, is an analysis of the average relative humidity from the surface to 500 mb/hPa. The values are plotted as a percentage for each reporting station (Figure 10-5). An "M" indicates the value is missing.

Analysis

Station circles are blackened for humidities of 50 percent and higher. Isopleths of relative humidity, called isohumes, are drawn and labeled every 10 percent with heavier isohumes drawn for values of 10, 50 and 90 percent.

Using the Panel

This panel is used to determine the average air saturation from the surface to 500 mb/hPa. Average relative humidities of 50 percent and greater are quite frequently associated with areas of clouds and possibly precipitation. Clouds and possible precipitation can be assumed, due to the high average relative humidity through approximately 18,000 feet. It is likely that a

layer or layers will have 100 percent relative humidity with clouds and possibly precipitation. It is important to remember that high values of relative humidity do not necessarily mean high values of water vapor content (precipitable water). For example (Figure 10-4), Las Vegas, NV has less water vapor content than New Orleans, LA (.43 and 1.34 respectively). However, in Figure 10-5, the average relative humidities are nearly the same for both stations. If rain were falling at both stations, the result would likely be lighter precipitation totals for Las Vegas.

USING THE COMPOSITE MOISTURE STABILITY CHART

This chart is used to determine the characteristics of a particular weather system in terms of stability, moisture, and possible aviation hazards. Even though this chart is several hours old when received, the weather system will tend to move these characteristics with it. Caution should be exercised as modification of these characteristics could occur through development, dissipation, or the movement of the system.

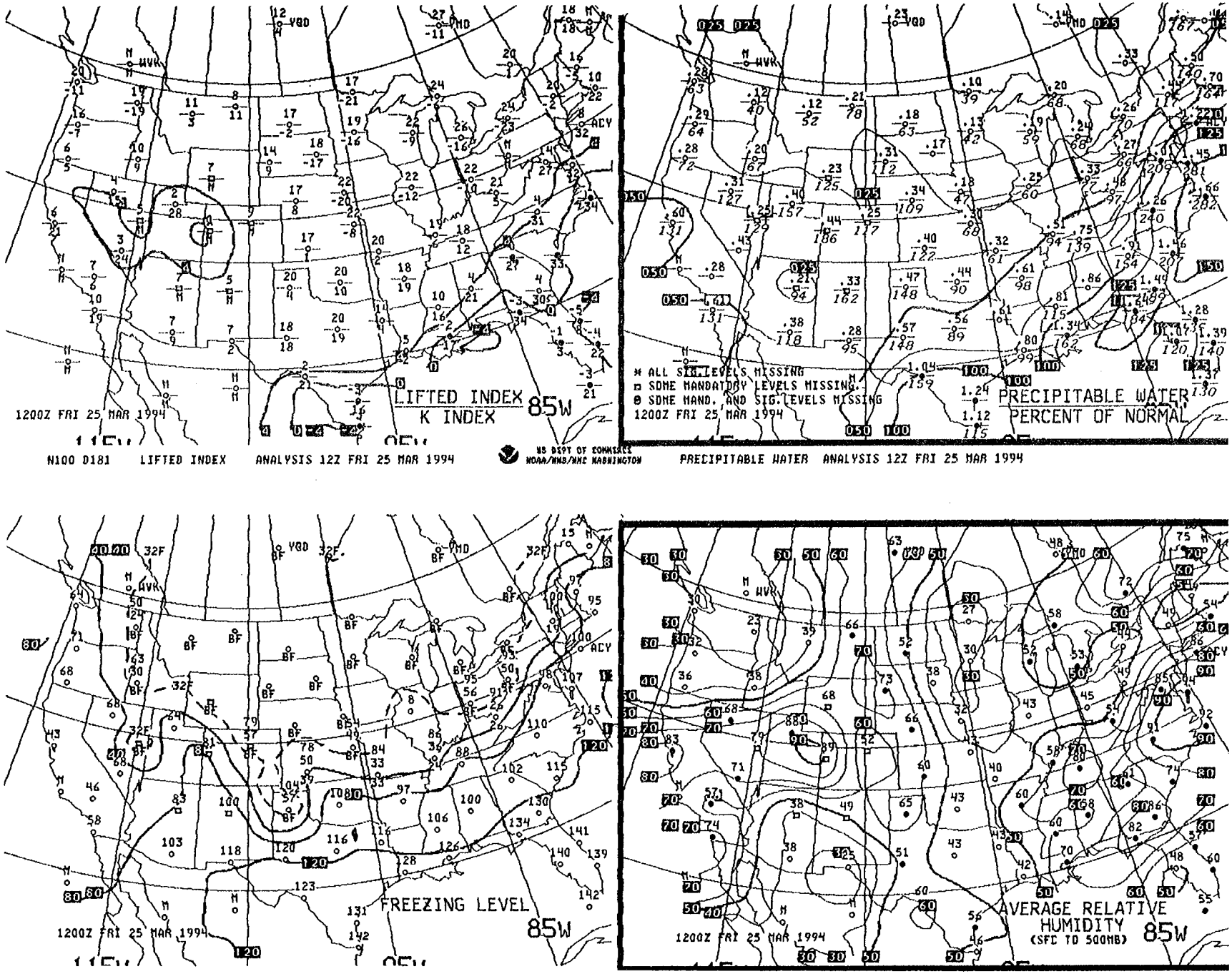


FIGURE 10-1. A Composite Moisture and Stability Chart

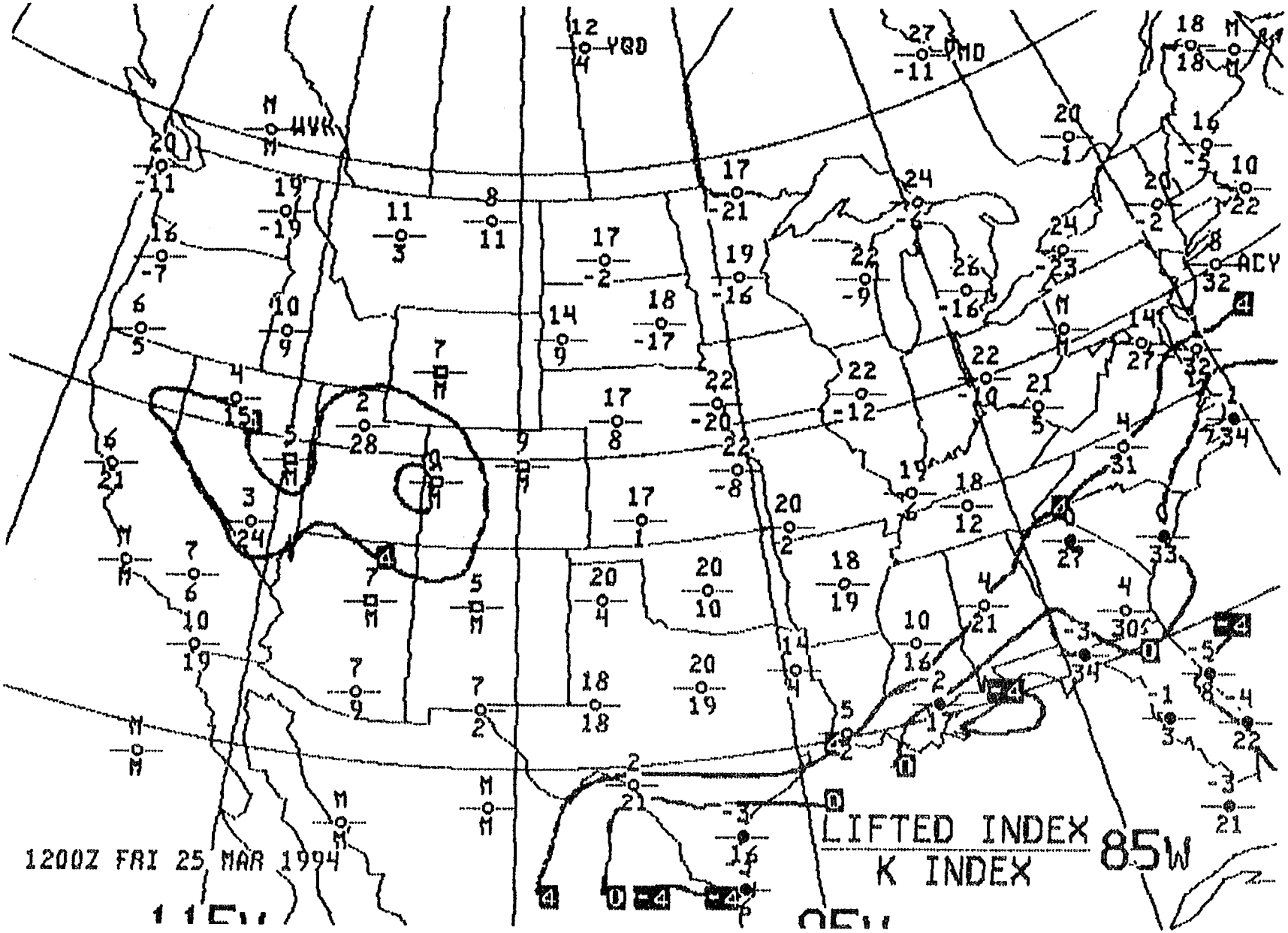


FIGURE 10-2. A Stability Panel from the Composite Chart

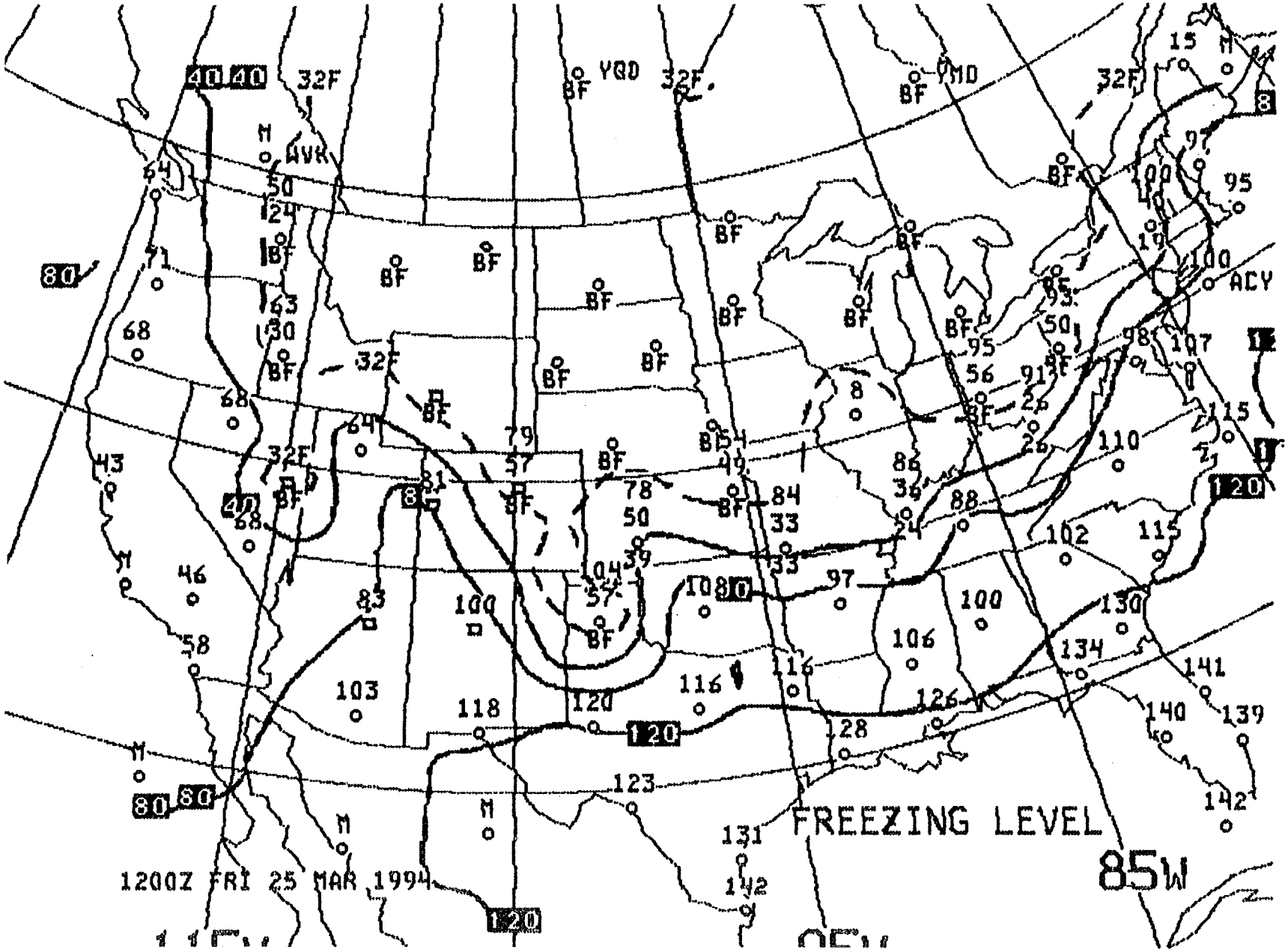


FIGURE 10-3. A Freezing Level Panel from the Composite Chart

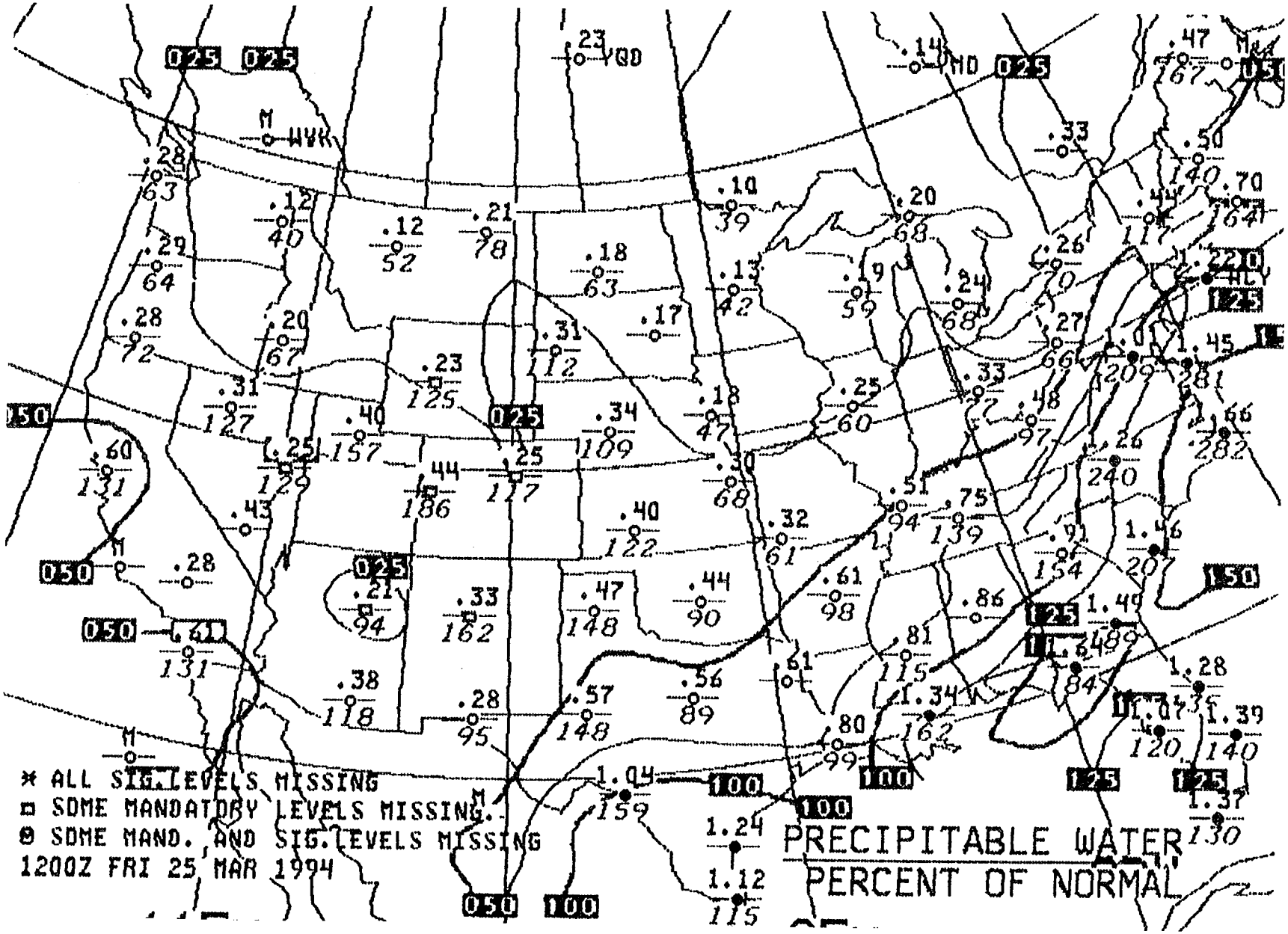


FIGURE 10-4. A Precipitable Water Panel from the Composite Chart

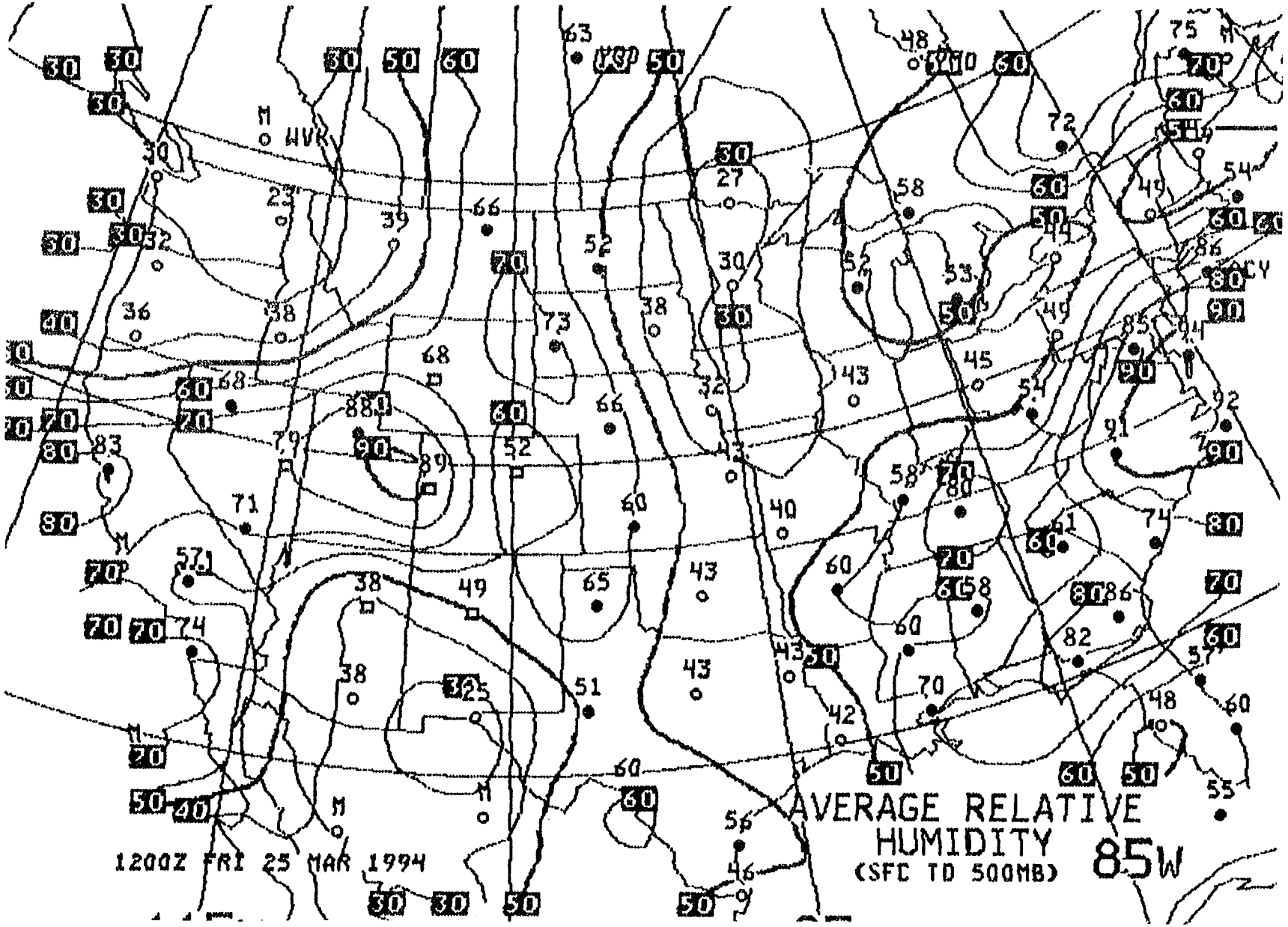


FIGURE 10-5. An Average Relative Humidity Panel from the Composite Chart

Section 11
SEVERE WEATHER OUTLOOK CHART

The severe weather outlook chart, Figure 11-1, is a 48-hour outlook for thunderstorm activity. This chart is presented in two panels. The left hand panel covers the first 24-hour period beginning at 12Z and depicts areas of possible general thunderstorm activity as well as severe thunderstorms. The right hand panel covers the following day beginning at 12Z and is an outlook for the possibility of severe thunderstorms only. This computer-prepared chart is issued once daily in the morning (about 08Z).

LEFT PANEL

A line with an arrowhead delineates an area of probable *general* thunderstorm activity. When facing in the direction of the arrow, the thunderstorm activity is expected to the right of the line. An area labeled "APCHG" indicates probable general thunderstorm activity may approach severe intensity. "Approaching" means, that at the surface, winds are greater than or equal to 35 knots, but less than 50 knots; and/or hail greater than or equal to 1/2 inch in diameter, but less than 3/4 inch at the surface. In Figure 11-1, from 12Z/25 MAR to 12Z/26 MAR, general thunderstorms are forecast for much of the southern half of the country except for Tennessee and portions of Arkansas, Mississippi, Alabama, Georgia, and the Carolinas. Note that the southern tip of Florida is not included in the general thunderstorm forecast area.

TABLE 11-1. Notation of Coverage

Notation	*Coverage*
SLIGHT RISK	2 to 5% coverage or 4 to 10 radar grid boxes containing severe thunderstorms per 100,000 square miles.
MODERATE RISK	6 to 10% coverage or 11 to 21 radar grid boxes containing severe thunderstorms per 100,000 square miles.
HIGH RISK	More than 10% coverage or more than 21 radar grid boxes containing severe thunderstorms per 100,000 square miles.

Severe Thunderstorms

The hatched area indicates possible severe thunderstorms. Table 11-1 shows the risk of severe thunderstorms and possible coverage. In Figure 11-1, there is a slight (SLGT) risk of severe thunderstorms in portions of Texas and Oklahoma.

RIGHT PANEL

On this panel, only severe thunderstorms are forecast. As this forecast panel is beyond the initial 24-hour period, only areas of possible severe thunderstorms are outlined. No reference to the potential or coverage is indicated. In Figure 11-1, the right panel indicates the possibility of severe thunderstorms from Texas and Oklahoma across the mid and lower Mississippi River Valley into the Ohio River Valley.

USING THE CHART

The severe weather outlook is strictly for advanced planning. It alerts all interests to the possibility of future storm development.

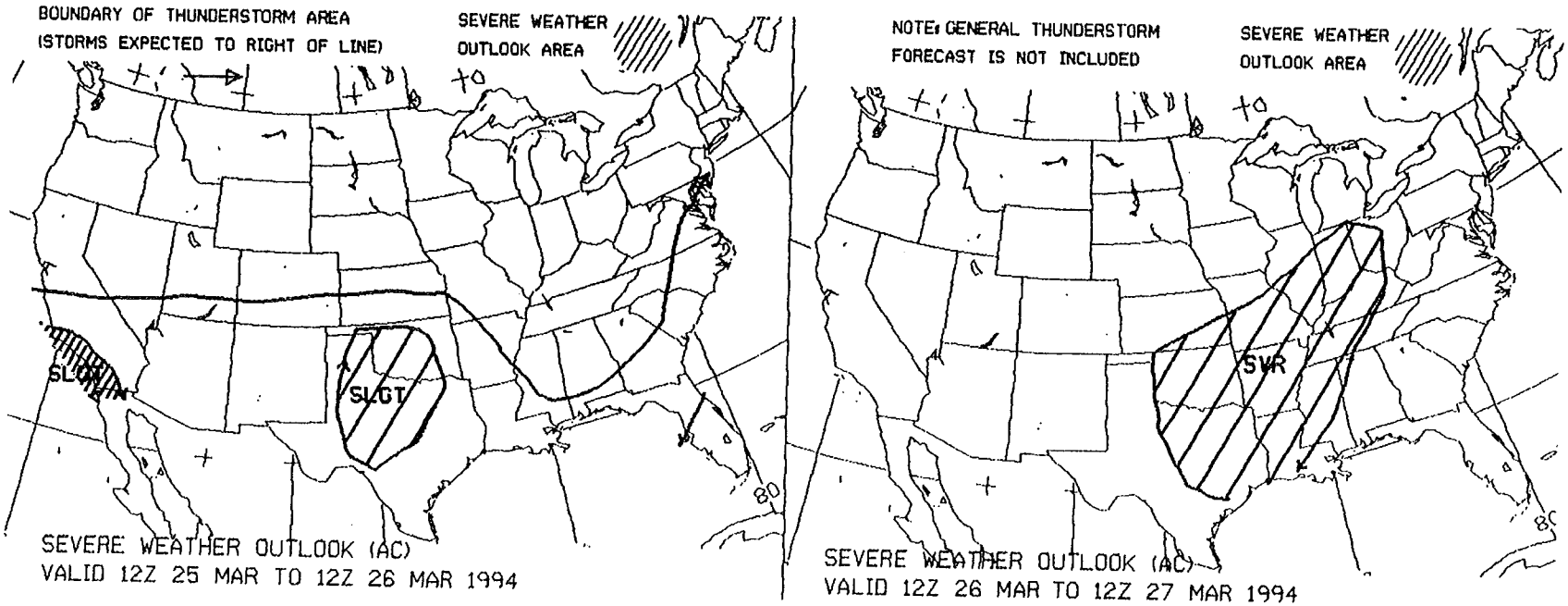


FIGURE 11-1. A Severe Weather Outlook Chart

Section 12

CONSTANT PRESSURE ANALYSIS CHARTS

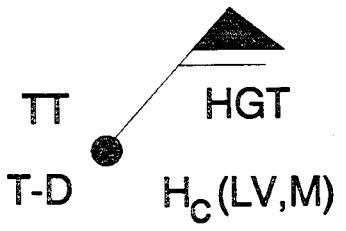
Any surface of equal pressure in the atmosphere is a constant pressure surface. A constant pressure analysis chart is an upper air weather map where all the information depicted is at the specified pressure of the chart. The analyses are referred to as specific millibar (mb) charts or in metric nomenclature, hectoPascal (hPa) charts.

Twice daily, six computer-prepared constant pressure charts (850 mb/hPa, 700 mb/hPa, 500 mb/hPa, 300 mb/hPa, 250 mb/hPa, and 200 mb/hPa) are transmitted over the facsimile circuits. The valid times of these charts are the same as the radiosonde time, 12Z and 00Z. Plotted for the specified level at each reporting station is observed temperature, temperature-dew point spread, wind, height of the pressure surface, and the height changes over the previous 12-hour period. Figures 12-2 through 12-7 are sections of each constant pressure chart.

Pressure altitude (height in the standard atmosphere) for each of the six pressure surfaces is shown in Table 12-1. For example, 700 millibars/hectoPascals of pressure has a pressure altitude of 10,000 feet in the standard atmosphere. In the real atmosphere 700 millibars/hectoPascals of pressure only closely approximates 10,000 feet, either above or below 10,000 feet, because the real atmosphere is seldom standard. For direct use of a constant pressure chart, assume a flight is planned at 10,000 feet. The 700 mb/hPa chart is approximately 10,000 feet MSL and is the best source for observed temperature, temperature-dew point spread, moisture, and wind for that flight level.

PLOTTED DATA

Figure 12-1 illustrates and decodes the standard radiosonde data plot. Table 12-2 gives a data plot example for each chart level. Aircraft and satellite observations are used in analysis over areas of sparse data. A square is used instead of a station circle to signify an aircraft report. The flight level of the aircraft is plotted in hundreds of feet. Temperature and wind data is also plotted for that flight level. The time of the report is indicated, to the nearest hour, UTC. For example, Figure 12-5 has an aircraft report at 40 degrees N and 140 degrees W. Decoded, the report indicates the flight level was 31,000 feet, the temperature was -47 degrees Celsius, winds were from 360 degrees at 20 knots, and the time of the report (to the nearest hour) was 1000 UTC. A star identifies satellite wind estimates made from cloud tops. Figure 12-4 is an example at about 41 degrees N and 62 degrees W. Decoded the report



Coded Term	Explanation
Wind	Wind direction and speed. Direction is plotted to the nearest 10 degrees and speed is plotted to the nearest 5 knots. See Figure 5-3 for the explanation of the symbols. If the direction or speed is missing, "M" is plotted in the Hc space. If speed is less than 3 knots, the wind is light and variable and an "LV" is plotted in the Hc space.
HGT	The actual height of the constant pressure surface is in meters (see Table 12-1 for decoding). If data is missing, nothing is plotted in this spot.
TT	The temperature to the nearest whole degree Celsius. If the temperature is below zero, a minus sign is used and if left blank, the temperature is missing. On the 850 mb/hPa chart, in mountain regions where stations may have an elevation above the 850 mb/hPa pressure level, a bracketed temperature is a computed value. If two temperatures are plotted, one above the other, the top temperature is used in the analysis.
T-D	The temperature-dew point spread, also called the depression, is to the nearest whole degree Celsius. If left blank, the T-D is missing. When the T-D is less than or equal to 5 degrees C, the station circle is blackened in. If the T-D is greater than 29 degrees C, an "X" is plotted. If the TT is -41 degrees C or below, the T-D is left blank.
Hc	This value shows the previous 12-hour height change and is plotted in tens of meters (decameters). Hc is not plotted when the wind is "LV" or "M." For example, a +04 means that the height of the pressure above the station has risen 40 meters, a -02 would show a height fall of 20 meters, and a +11 would mean a height rise of 110 meters.

FIGURE 12-1. Radiosonde Data Station Plot.

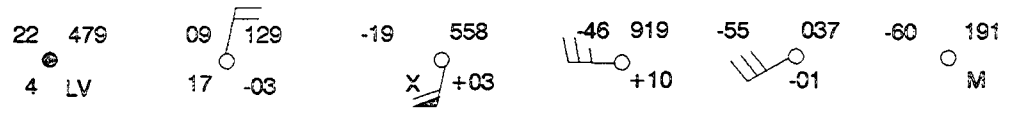
TABLE 12-1. Features of the Constant Pressure Charts - U.S.

PRESSURE (millibars/hectoPascals)	PRESSURE ALLLTITUDE in feet (flight level)	PRESSURE ALTITUDE in meters	TEMPERATURE DEW/POINT SPREAD	ISOTACHS	CONTROL INTERVAL (meters)	DECODE STATION HEIGHT PLOT		EXAMPLES OF STATION HEIGHT PLOTTING	
						PREFIX TO PLOTTED VALUE	SUFFIX TO PLOTTED VALUE	PLOTTED	HEIGHT
850	5,000	1,500	yes	no	30	1	—	530	1,530
700	10,000	3,000	yes	no	30	2 or 3*	—	180	3,180
500	18,000	5,500	yes	no	60	——	0	582	5,820
300	30,000	9,000	yes**	yes	120	——	0	948	9,480
250	34,000	10,500	yes**	yes	120	1	0	063	10,630
200	39,000	12,000	yes**	yes	120	1	0	164	11,640

NOTE:

1. The pressure altitudes are rounded off to the nearest thousand for feet and to the nearest 500 for meters.
2. All heights are above Mean Sea Level (MSL).
3. * Prefix a "2" or "3," whichever brings the height closer to 3,000 meters.
4. ** Omitted when the air is too cold (temperature less than -41 degrees).

TABLE 12-2. Examples of radiosonde plotted data.



	850 MB/hPa	700 MB/hPa	500 MB/hPa	300 MB/hPa	250 MB/hPa	200 MB/hPa
WIND	LIGHT AND VARIABLE	010/20 KTS	210/60 KTS	270/25 KTS	240/30 KTS	MISSING
TT	22 C	9 C	-19 C	-46 C	-55 C	-60 C
T-D	4 C	17 C	>29 C	not plotted	not plotted	not plotted
DEW POINT	18 C	-8 C	DRY	DRY	DRY	DRY
HGT	1,479 m	3,129 m	5,580 m	9,190 m	10,370 m	11,910 m
Hc	not plotted	- 30 m	+ 30 m	+ 100 m	+ 10 m	not plotted

indicates that the height was about 19,000 feet, winds were from 260 degrees at 30 knots, and the time of the report (to the nearest hour) was 1100 UTC.

ANALYSIS

All charts contain contours, isotherms and some contain isotachs. Contours are lines of equal heights, isotherms are lines of equal temperature, and isotachs are lines of equal wind speed.

Height Contours

Heights of the specified pressure for each station are analyzed through the use of solid lines called contours. This contour analysis gives the charts a *height* pattern. The contours depict highs, lows, troughs, and ridges aloft in the same manner as isobars on the surface chart. On an upper air chart, then, we speak of "high or low height centers" instead of "high or low pressure centers." Comparing a height analysis to a pressure analysis note that a *contour* high, low, trough, or ridge is analogous to a pressure high, low, trough, or ridge. Also note that the two terms may be used interchangeably as height and pressure analyses are just two ways of describing the same features.

Since an upper air chart is above the surface friction layer, winds for all practical purposes flow parallel to the contours. To decode contour values on the 850 mb/hPa through 300 mb/hPa chart, simply affix a zero to the end of the three-digit code. On the 200 mb/hPa and 250 mb/hPa chart, a one (1) must be prefixed to the three-digit code in addition to placing a zero at the end of the code.

Isotherms

Isotherms are dashed lines drawn at 5-degree Celsius intervals. The isotherm analysis show the horizontal temperature variations at that chart altitude. Figure 12-2 is an example of a 850 mb/hPa chart. Note the dashed line extending from near Albuquerque, NM east to near Atlanta, GA and labeled "+10" in west Texas. This is the +10 degree isotherm. North of this isotherm, the temperatures, at approximately 5,000 feet, are below +10 degrees Celsius; and south of the isotherm, the temperatures are above +10 degrees Celsius. By inspecting the isotherm pattern, one can determine if a flight would be toward colder or warmer air. Subfreezing temperatures and a temperature-dew point spread of 5 degrees Celsius or less would indicate the possibility of icing. On the 300, 250 and 200 mb/hPa charts, the isotherms are the heavy dashed lines.

Isotachs

Isotachs, the short, lightly dashed lines, appear only on the 300, 250 and 200 mb/hPa charts. Isotachs are drawn at 20 knot intervals beginning at 10 knots. To aid in identifying areas of strong winds, hatching denotes wind speeds of 70 to 110 knots. A clear area within a hatched area indicates that the wind speed is between 110 and 150 knots. In Figure 12-6, note the alternating hatched/clear areas that extends from west of California into the south central U.S. The clear area, within the hatching, indicates winds greater than 110 knots, but less than 150 knots, while the small hatched area inside the clear area indicates winds greater than 150 knots.

THREE DIMENSIONAL ASPECTS

As established earlier, a height analysis may be treated as a pressure analysis. Closely spaced contours indicate strong winds just like closely spaced isobars. Winds blow clockwise around a contour high and counterclockwise around a low.

Features on a synoptic surface chart and the associated upper air charts are generally related. However, a weak surface system often either loses its identity in a large scale upper air pattern or another system may be more evident on the upper air charts than on the surface chart. If fact, many times weather is more closely associated with an upper air pattern than with the features on the surface map.

As a general rule, a surface low is a producer of bad weather and a high is a producer of good weather. Usually this is true, but an upper air low or trough usually means bad weather, also. The area of cloudiness and precipitation found with an upper air low is usually associated with a surface low. Sometimes an upper level low with clouds and precipitation will move over a shallow surface high with corresponding bad weather in the high. As with a surface high, an upper air high usually means good weather. An exception would be an upper air high or ridge that has a stabilizing effect on the layers of the atmosphere below it. Smoke, haze, dust, low stratus, and fog may persist for an extended period but the surface map shows no cause for the restriction.

Lows generally slope to the west, toward colder air, with ascending altitude for developing low pressure systems. Due to this slope, winds aloft with an upper system often blow across the associated surface system. Surface fronts, lows, and highs tend to move with the upper winds. For example, strong winds aloft across a front will cause the front to move rapidly, but if upper winds are parallel to a front, it moves slowly, if at all.

An old, nondeveloping low pressure system tilts little with height. The low becomes almost vertical and is

clearly evident on both surface and upper air maps. Upper winds encircle the surface low, rather than blow across it causing the storm to move very slowly. As a result, extensive and persistent cloudiness, precipitation, and generally adverse flying weather occur. The term "cold low" describes such a system and is usually identified on the surface chart as an old, occluded low with the warm air having been cut-off from the low pressure center.

In contrast to the cold low is the "thermal low". A dry, sunny region becomes quite warm from intense surface heating. This results in a surface low pressure area. The warm air is carried to high levels by convective currents, but very few clouds occur because of the lack of moisture. This warm surface low often is "capped" by a high aloft. Unlike the cold low, the thermal low is relatively shallow with weak pressure gradients and no well-defined cyclonic circulation. However, be alert for high density altitude, light to moderate convective turbulence and isolated showers and thunderstorms if sufficient moisture is present. The thermal low is a semipermanent feature of the desert regions in the southwestern United States and northern Mexico during warm weather.

These are only a few examples of associating weather with upper air features. They point out the need to view weather in the three dimensions to get a "big picture" of the atmosphere. This is the first step in understanding the atmosphere and its associated weather.

USING THE CHARTS

From these charts, a pilot can approximate the observed temperature, wind, and temperature-dew point spread along a proposed route. A constant pressure chart usually can be selected close to a proposed flight altitude. For an altitude about midway between two charted surfaces, interpolate between the two charts.

Determine temperature from plotted data or the pattern of isotherms. To find areas of high moisture content, look for reports that have the station circle shaded. This indicates a temperature-dew point spread of 5-degrees Celsius or less. A small spread indicates the possibility of clouds, precipitation, and icing.

Wind speed from the 300, 250, and 200 mb/hPa charts can be determined by the isotachs. Below this level, wind speeds can be determined from the plotted data.

As stated earlier, constant pressure charts often show the cause of weather and its movement more clearly than does the surface map. For example, the large scale wind flow around a low aloft may spread cloudiness, low ceilings, and precipitation far more extensively than indicated by the surface map alone.

Note: Keep in mind that constant pressure charts are observed weather.

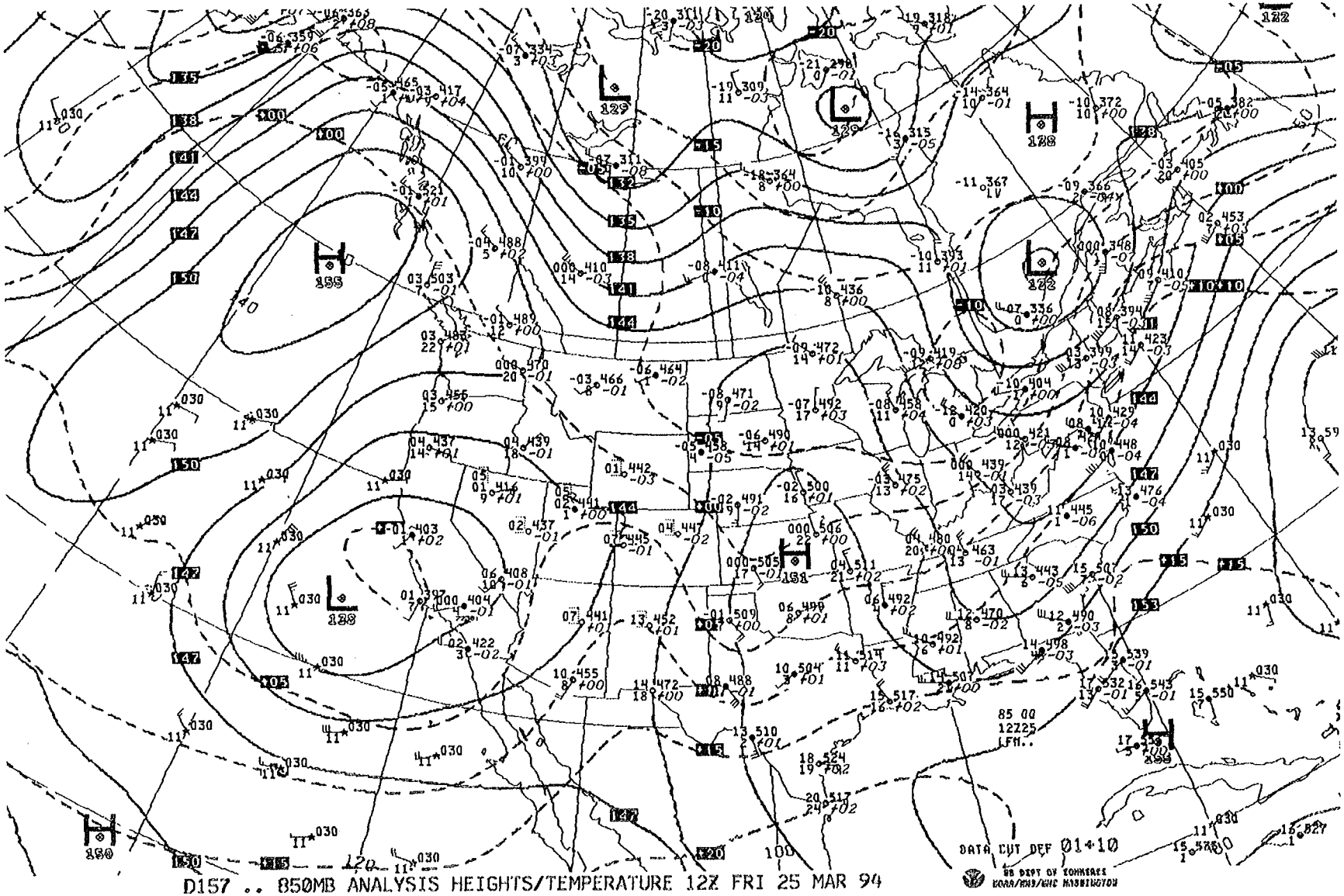


FIGURE 12-2. An 850 Millibar/HectoPascal Analysis (pressure altitude 5,000 ft)

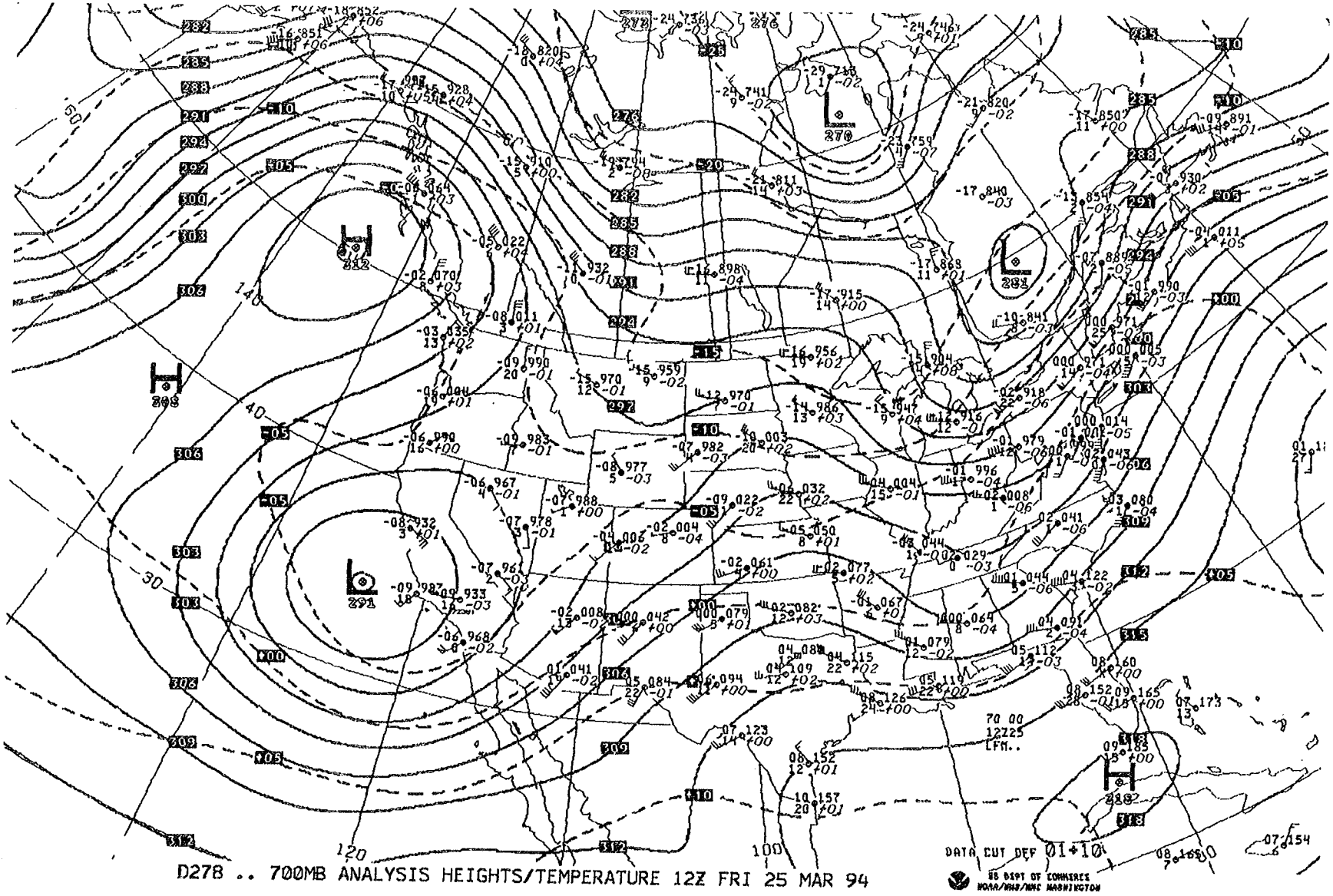


FIGURE 12-3. A 700 Millibar/HectoPascal Analysis (pressure altitude 10,000 ft)

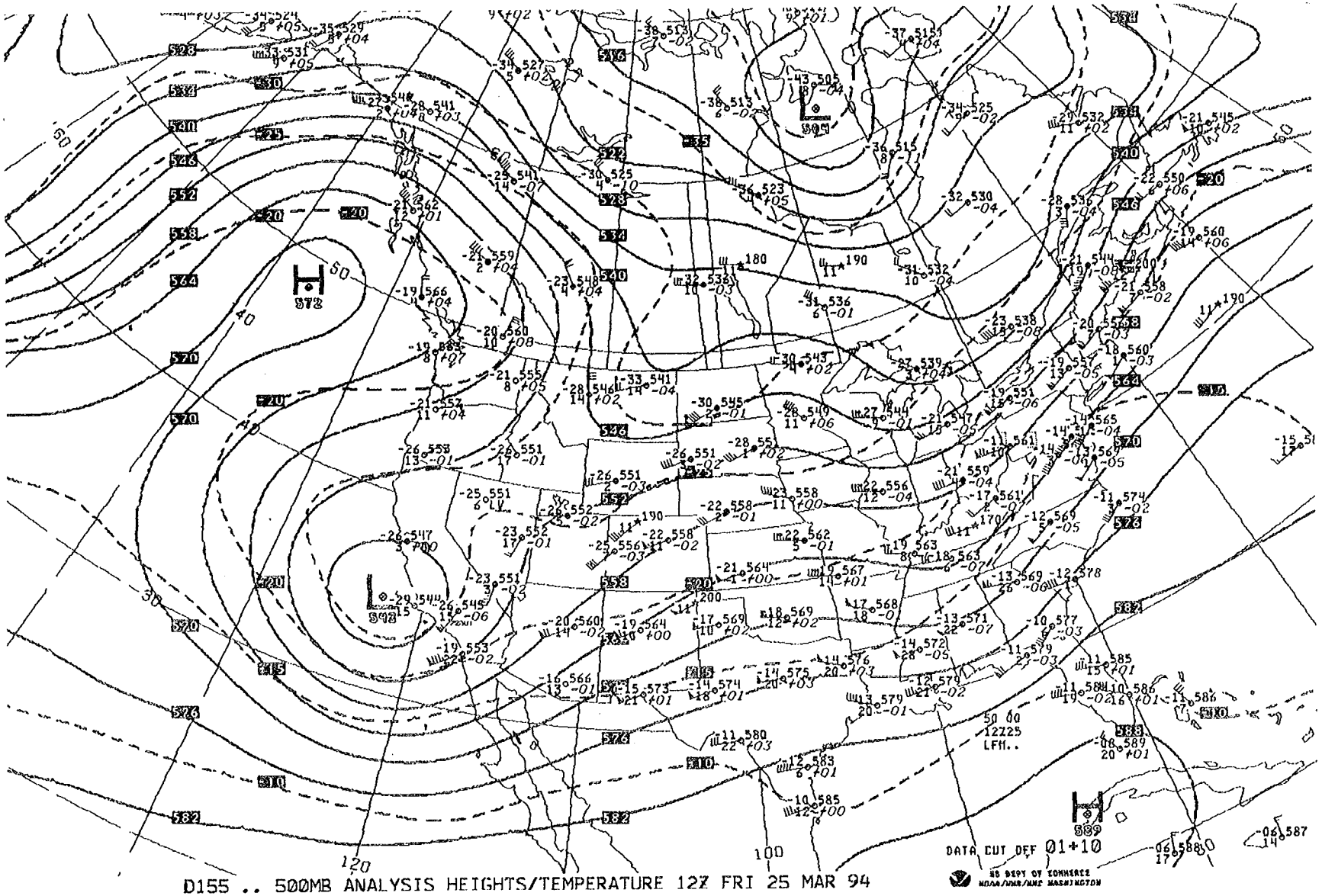


FIGURE 12-4. A 500 Millibar/HectoPascal Analysis (pressure altitude 18,000 ft)

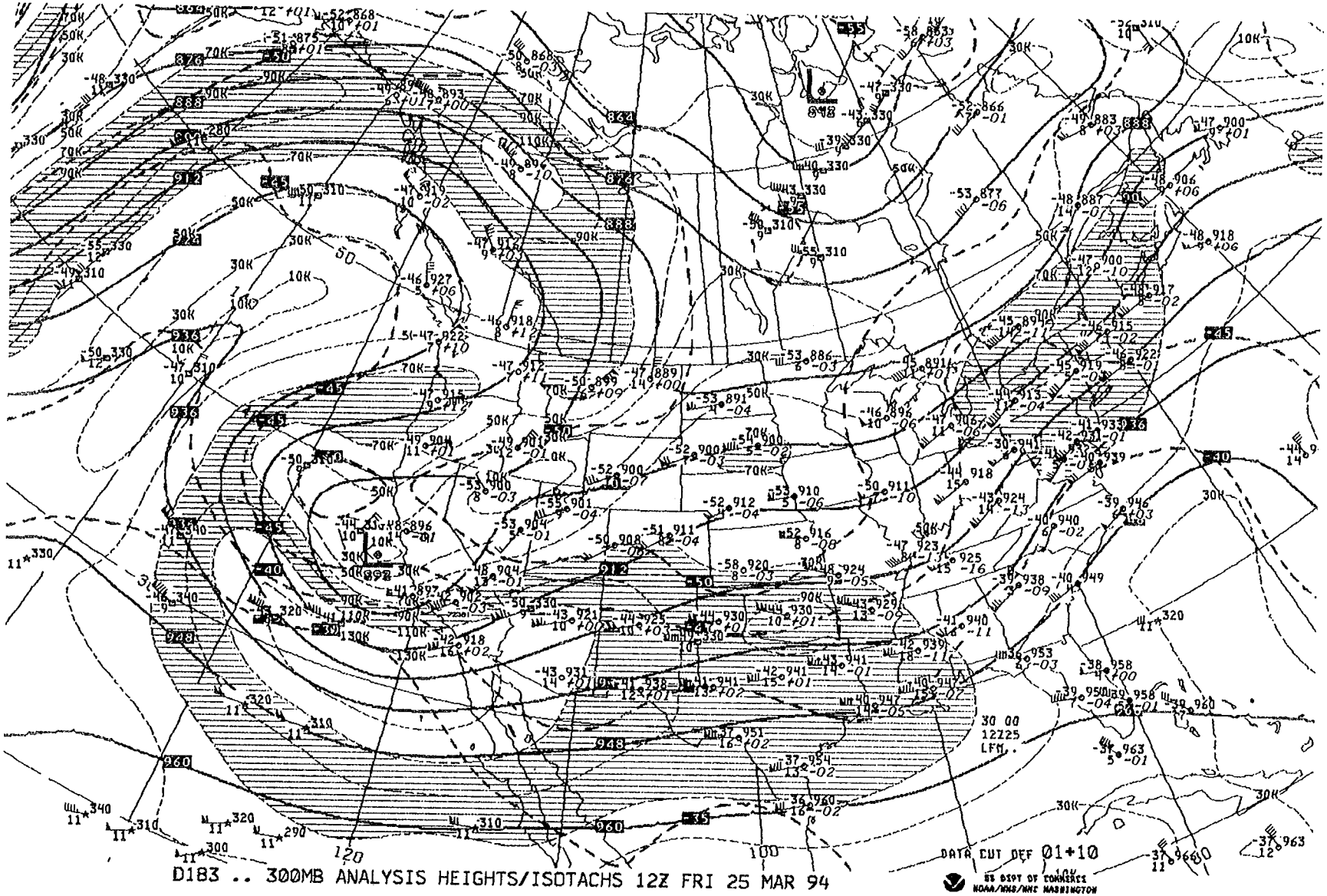


FIGURE 12-5. A 300 Millibar/HectoPascal Analysis (pressure altitude 30,000 ft)

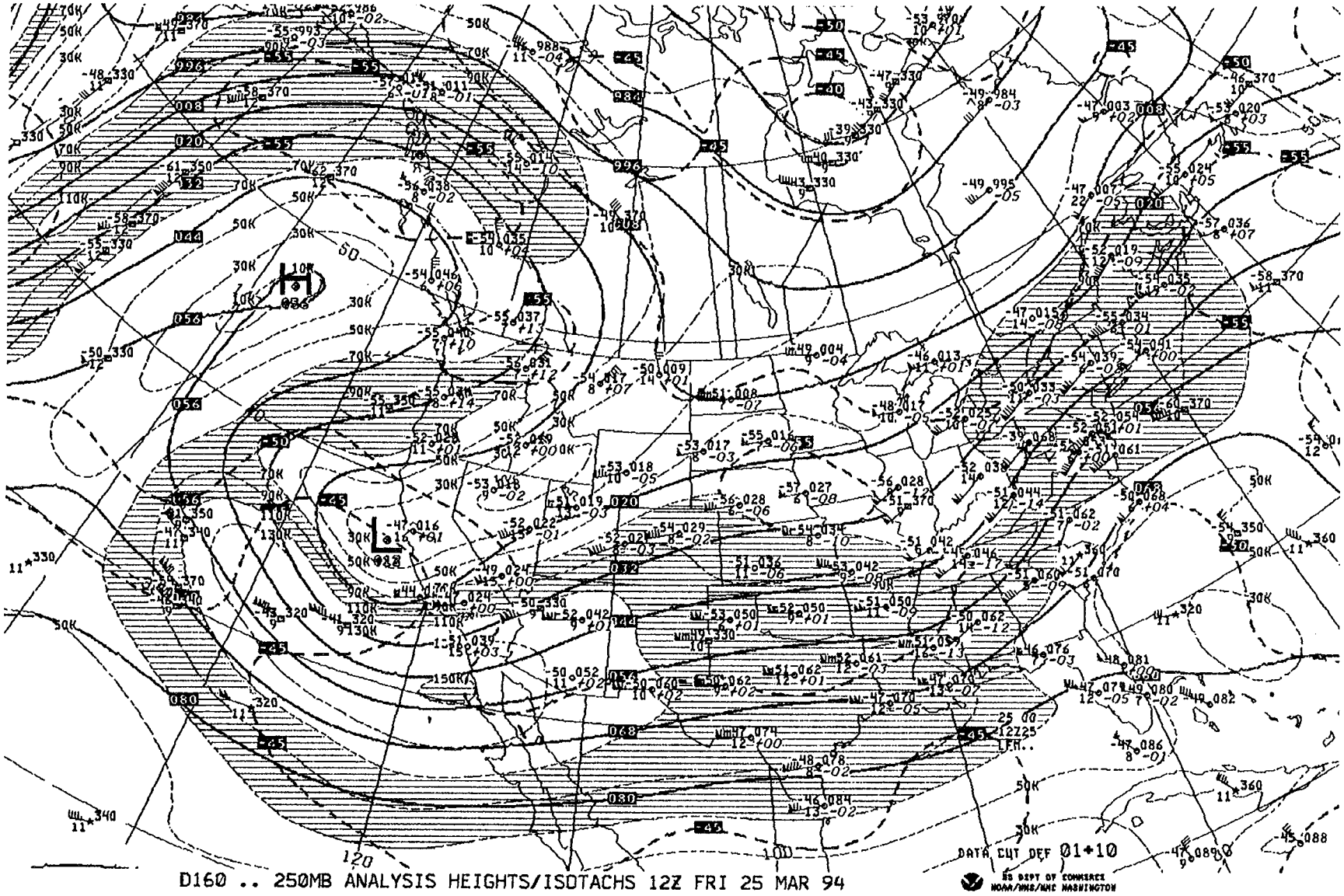


FIGURE 12-6. A 250 Millibar/HectoPascal Analysis (pressure altitude 34,000 ft)

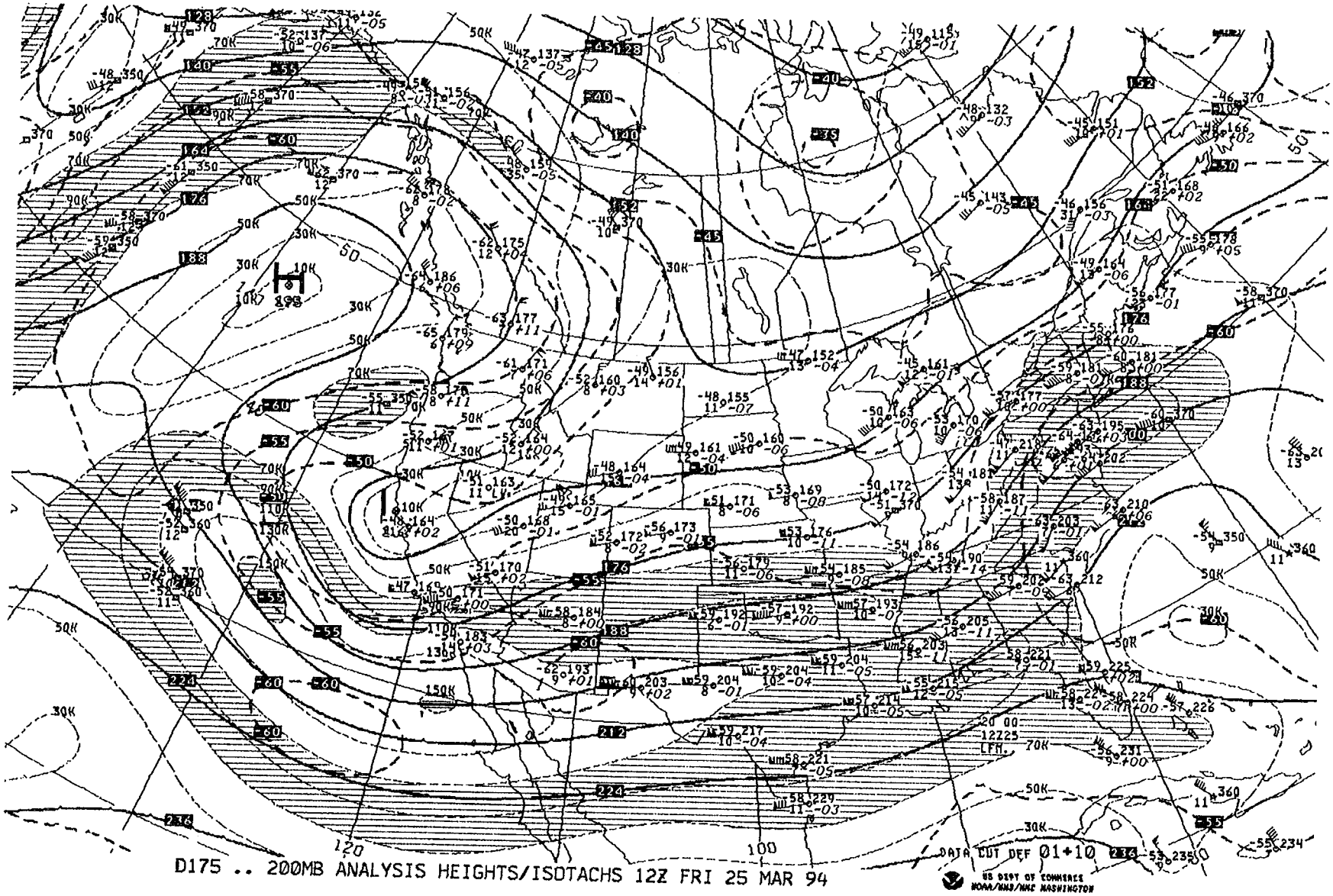


FIGURE 12-7. A 200 Millibar/HectoPascal Analysis (pressure altitude 39,000 ft)

Section 13

TROPOPAUSE DATA CHART

The tropopause data chart is a two-panel chart containing a maximum wind prog and a vertical wind shear prog. The chart is prepared for the contiguous 48 states (Figure 13-1) and is available once a day with a valid time of 18Z.

DOMESTIC TROPOPAUSE WIND AND WIND SHEAR PROGS

Both panels show forecast parameters at the tropopause level. The first panel depicts the forecast winds at the tropopause and the second panel gives the tropopause height and vertical wind shear (VWS).

Tropopause Winds

The tropopause winds prog, Figure 13-2, depicts wind direction by streamlines. The streamlines are the solid lines that are not labeled. Since winds parallel the streamlines and generally flow from west to east, direction can be obtained by following the streamline flow. A high or low may be encircled by a closed streamiine. Determining if a closed streamline is a high or low is done by remembering the circulation around these systems.

Wind speed is shown by isotachs at 20-knot intervals. The isotachs are the dashed lines and are labeled in knots. Areas of wind speeds between 70 and 110 knots are hatched as are wind speeds between 150 and 190 knots. Note that the shading criteria is the same as used on the higher level constant pressure analysis and progs.

Tropopause Height/Vertical Wind Shear (VWS)

The tropopause height/vertical wind shear prog (Figure 13-3) depicts the height of the tropopause in terms of pressure altitude and vertical wind shear in knots per 1,000 feet. For an explanation of vertical wind shear, see AVIATION WEATHER, AC 00-6A, Chapter 3. The solid lines trace intersections of the tropopause with standard constant pressure surfaces. Heights are preceded by the letter "F" and are in hundreds of feet.

Vertical wind shear is in knots per 1,000 feet and is depicted by dashed lines at 2-knot intervals. Wind shear is averaged through a layer from about 8,000 feet below to 4,000 feet above the tropopause.

The following is a list of pressure and corresponding flight levels:

Millibars/HectoPascals	Flight Level
500	18,000
450	21,000
400	24,000
350	27,000
300	30,000
250	34,000
200	39,000
150	45,000
100	53,000
70	63,000

USING THE PANELS

The progs are issued once daily and may be used for a period of up to plus or minus 6 hours from the valid time. The panels may be used to determine vertical and horizontal wind shear as clues to probable wind shear turbulence (see pages 15-1 and 15-2 for criteria). The charts may be also used to determine winds for high level flight planning.

Although neither panel depicts the jet stream, locating the jet is not difficult. The jet passes through the isotach and vertical shear maxima. For example, (Figure 13-2) a jet maximum extends from eastern Washington and Oregon extending south and slightly west through central California. It reappears near the southwest corner of the panels, and enters the U.S. near the Arizona-New Mexico border. The jet then extends northeast across central Nebraska and swings east through the central Great Lakes and into southern New England.

Horizontal wind shear can be determined from the spacing of the isotachs. The horizontal wind shear critical for turbulence (moderate or greater) is greater than 18 knots per 150 miles. For further information, see AVIATION WEATHER, AC 00-6A, Chapter 13 on clear air turbulence. Note that 150 nautical miles is equal to about 2 1/2 degrees longitude.

For example, lay a pencil along a meridian in the

Atlantic Ocean. The spacing on the longitude lines is 10 degrees. Measure 2 1/2 degrees and move the pencil perpendicular to the isotach across north central Montana. Note that the horizontal shear, the difference in wind speed, is about 40 knots along this distance. This spacing represents the wind shear critical for probable moderate or greater wind shear turbulence. The strong wind shear from southwest Arizona to northwest Minnesota suggests a probability of turbulence due to horizontal wind shear.

Vertical wind shear can be determined directly from the dashed lines in Figure 13-3. The vertical shear critical for probable turbulence is 6 knots per 1,000 feet. This critical value can be found in central California and from west Nebraska to the Great Lakes. An area of extremely high probability of moderate or greater turbulence is the three state junction of the Dakotas and Minnesota. This is where the horizontal shear is about 80 knots per 150 miles and the vertical shear is in excess of 6 knots per 1,000 feet.

Wind direction and speed at the tropopause flight level may be read directly from the streamlines and isotachs. To determine wind at a flight level below and above the tropopause, determine the direction and speed at the tropopause. Since wind direction changes very little within several thousand feet of the tropopause, this direction may be used throughout the layer for which vertical wind shear is computed. Next, determine wind shear and the number of thousands of feet the desired flight level differs from the flight level of the tropopause.

For example, assume a westbound flight wants to know the probability of turbulence and the wind for a leg from Amarillo and Albuquerque. Figure 13-2 indicates that the possibility of horizontal wind shear is negligible (less than 18 knots per 150 miles). Vertical wind shear (Figure 13-3) is interpolated between the 4- and 6-knot shear lines and is about 5 knots per 1,000 feet. Widespread significant turbulence (moderate or greater) is unlikely. Also, refer to the high-level significant weather prog and pilot reports for further information about turbulence.

Wind direction along the route, determined from the streamlines, is about 230 degrees. Speed is strongest at the tropopause, so a westbound flight should choose a flight level as far as practical above or below the tropopause. For a tropopause of 39,000 feet (200 mb/hPa), a flight level at 43,000 would be appropriate. Figure 13-2 indicates the wind at the tropopause to be on the high side of the 130 knot isotach. A good estimate would be a speed of 135 knots. The flight level of 43,000 feet is 4,000 feet above the tropopause. Multiply the 5-knot shear by four. Subtract the 20 knots from 135, the wind speed at the tropopause, to obtain a speed of 115 knots. Therefore, the wind speed at FL430 is approximately 230 degrees at 115 knots.

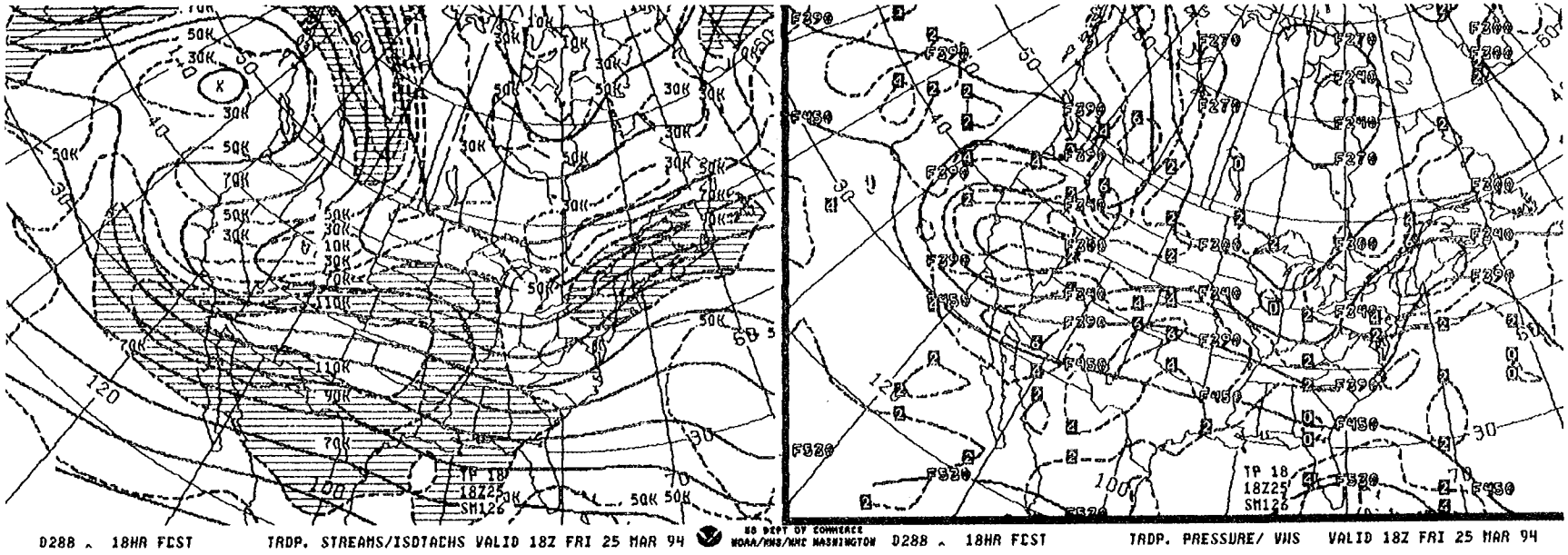


FIGURE 13-1. A Tropopause Data Chart

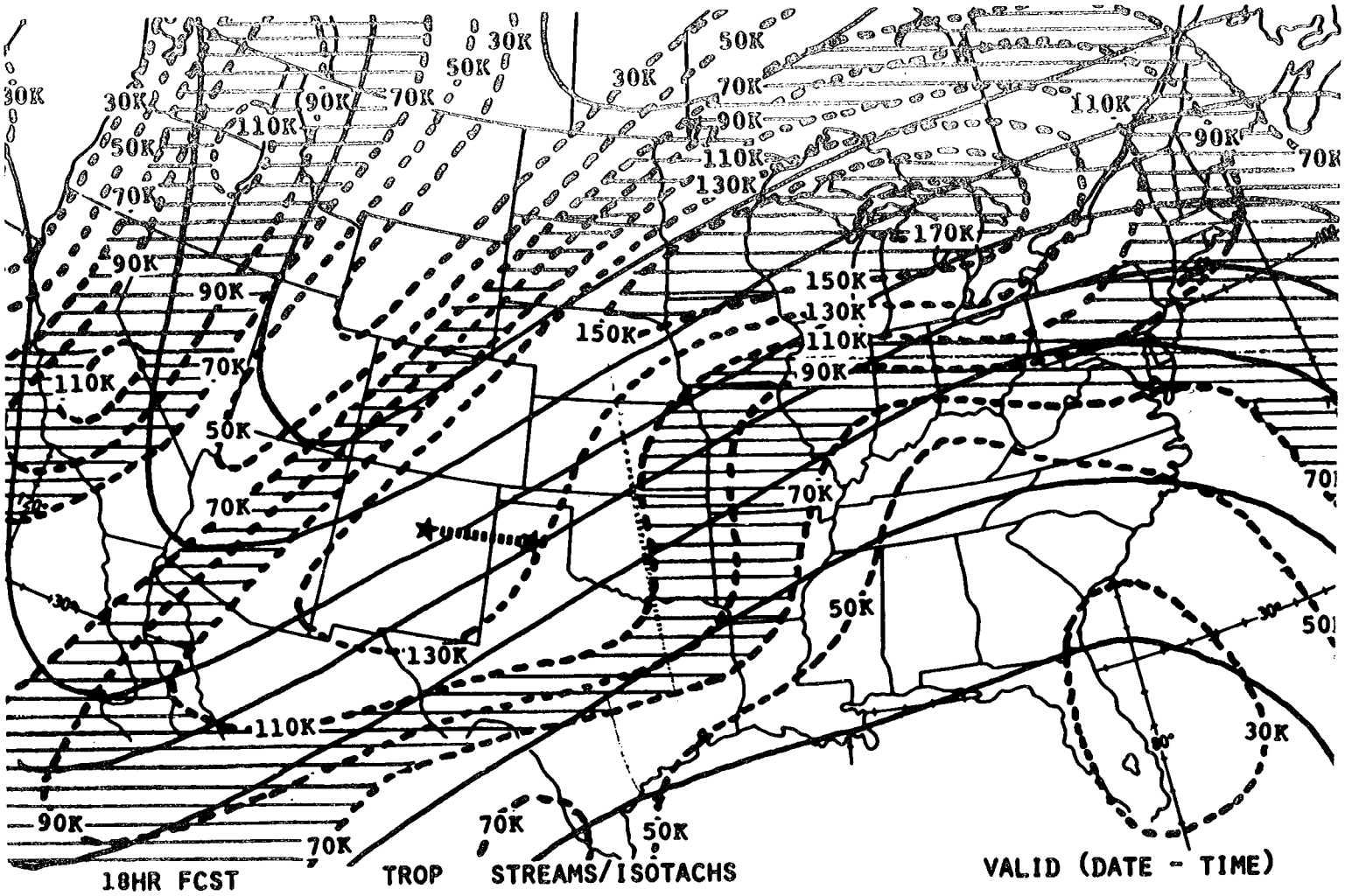


FIGURE 13-2. A section of a tropopause wind prog.

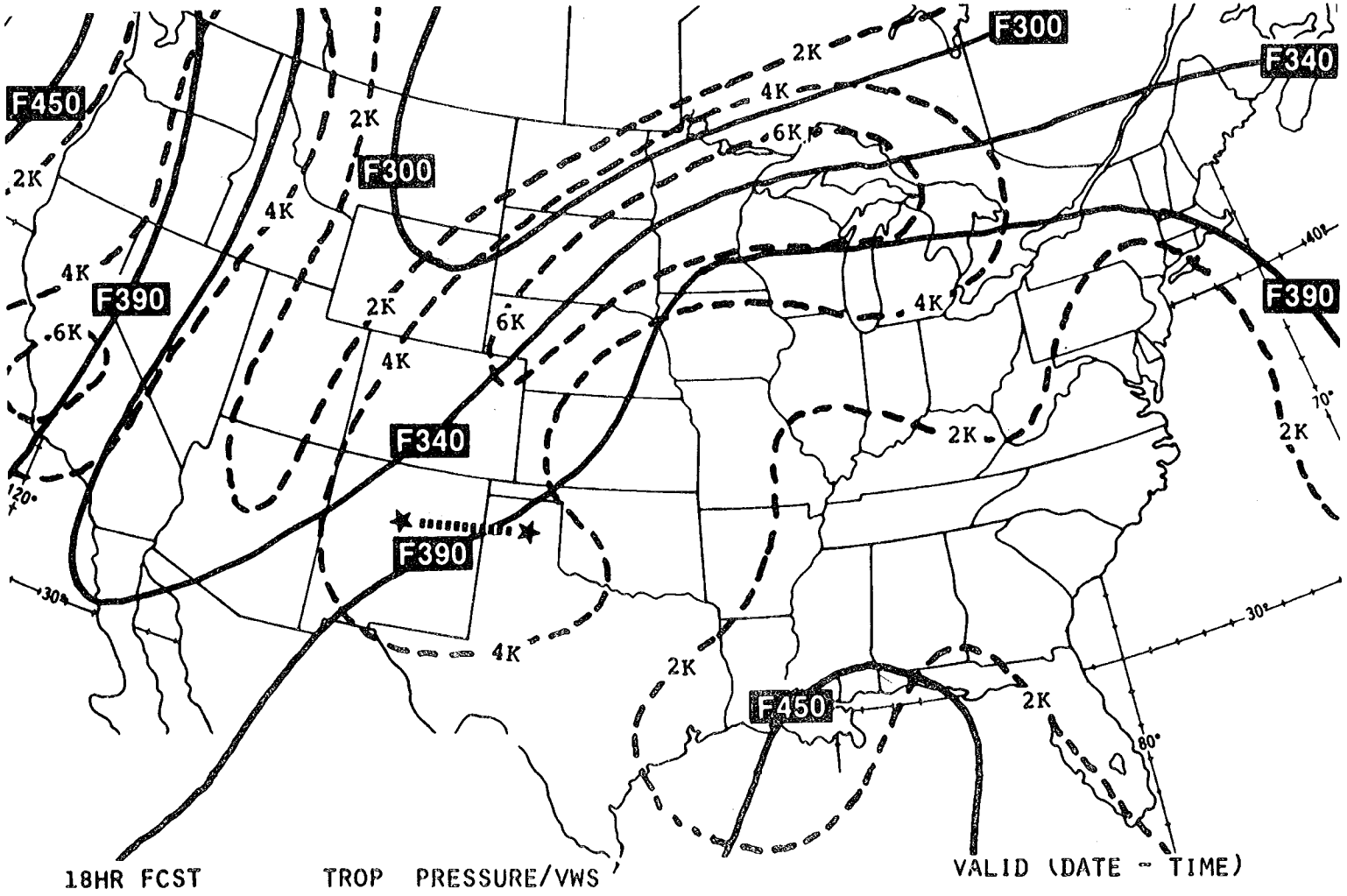


FIGURE 13-3. A section of a tropopause height/vertical wind prog.

Section 14

VOLCANIC ASH FORECAST TRANSPORT AND DISPERSION CHART

The Volcanic Ash Forecast Transport and Dispersion (VAFTAD) Chart, Figures 14-2 and 14-3, is generated by a 3-dimensional time-dependent dispersion model developed by NOAA's Air Resources Laboratory (ARL). The VAFTAD model focuses on hazards to aircraft flight operations caused by a volcanic eruption with an emphasis on the ash cloud location in time and space. It uses National Meteorological Center (NMC) forecast data to determine the location of ash concentrations over 6-hour and 12-hour time intervals, with valid times beginning 6, 12, 24, and 36 hours following a volcanic eruption. The output is made available on graphics distribution networks supported by the NWS. This computer-prepared chart is not issued on a routine basis. Rather, it is issued as volcanic eruptions are reported.

Since the VAFTAD chart is triggered by the occurrence of a volcanic eruption, PIREPs concerning volcanic activity are very important. Initial input to the VAFTAD model run and the resulting chart includes;

-Geographic region
-Volcano name
-Volcano latitude and longitude
-Eruption date and time, and
-Initial ash cloud height.

Utilizing NMC meteorological forecast guidance, volcanic ash particle transport and dispersion is depicted horizontally and vertically through representative atmospheric layers. The model does take into account ash particle fall with the passage of time.

VAFTAD PRODUCT

The VAFTAD product presents the relative concentrations of ash following a volcanic eruption for three layers of the atmosphere in addition to a composite of ash concentration through the atmosphere.

Atmospheric layers depicted are:

-Surface to flight level 200
-Flight level 200 to flight level 350, and
-Flight level 350 to flight level 550.

Figure 14-2 is a sample VAFTAD 8-panel chart (for DIFAX transmission) of ash cloud relative concentrations for 6 to 12 hours, and 12 to 24 hours after a volcanic eruption. Figure 14-3 is a sample chart for the 12-hour time intervals 24 to 36, and 36 to 48 hours after an eruption. Note that the first six hours after the volcanic eruption are not depicted. **[An appropriate SIGMET will be issued for that period concerning the volcanic eruption and the area affected by the ash cloud.]**

The four panels in any column are valid for the same time interval (specified and located below the third panel). The top three panels in each column provide the ash location and relative concentrations for an atmospheric layer, identified by top and bottom flight levels. The highest layer is at the top of the chart. The bottom panels are the total ash concentrations from the surface up through flight level 550. Volcano eruption information is given at the lower left (See Figure 14-1) which includes the volcano name (with location symbol), latitude and longitude, eruption date and time, and initial ash cloud height. The legend for relative concentrations (see Table 14-1) is at the lower right corner of the chart. A relative concentration symbol on a map reflects a maximum forecast value at a location during the time interval.

FIGURE 14-1. Volcano Emission Information

Mt. Spurr Eruption
61.3N 152.3W 12Z 28 JUL 93
40000 FT ASH CLOUD HEIGHT

TABLE 14-1. Ash Concentration

Concentration	*Symbol*
LOW	(/)
MODERATE	(+)
HIGH	(■)

USING THE CHART

The VAFTAD chart is strictly for advanced flight planning purposes. It is not intended to take the place of SIGMETs regarding volcanic eruptions and ash. The actual presentation of the VAFTAD Chart may change as international requirements are reviewed.

CHART REDUCED HERE TO 0.64 ACTUAL TRANSMISSION SIZE

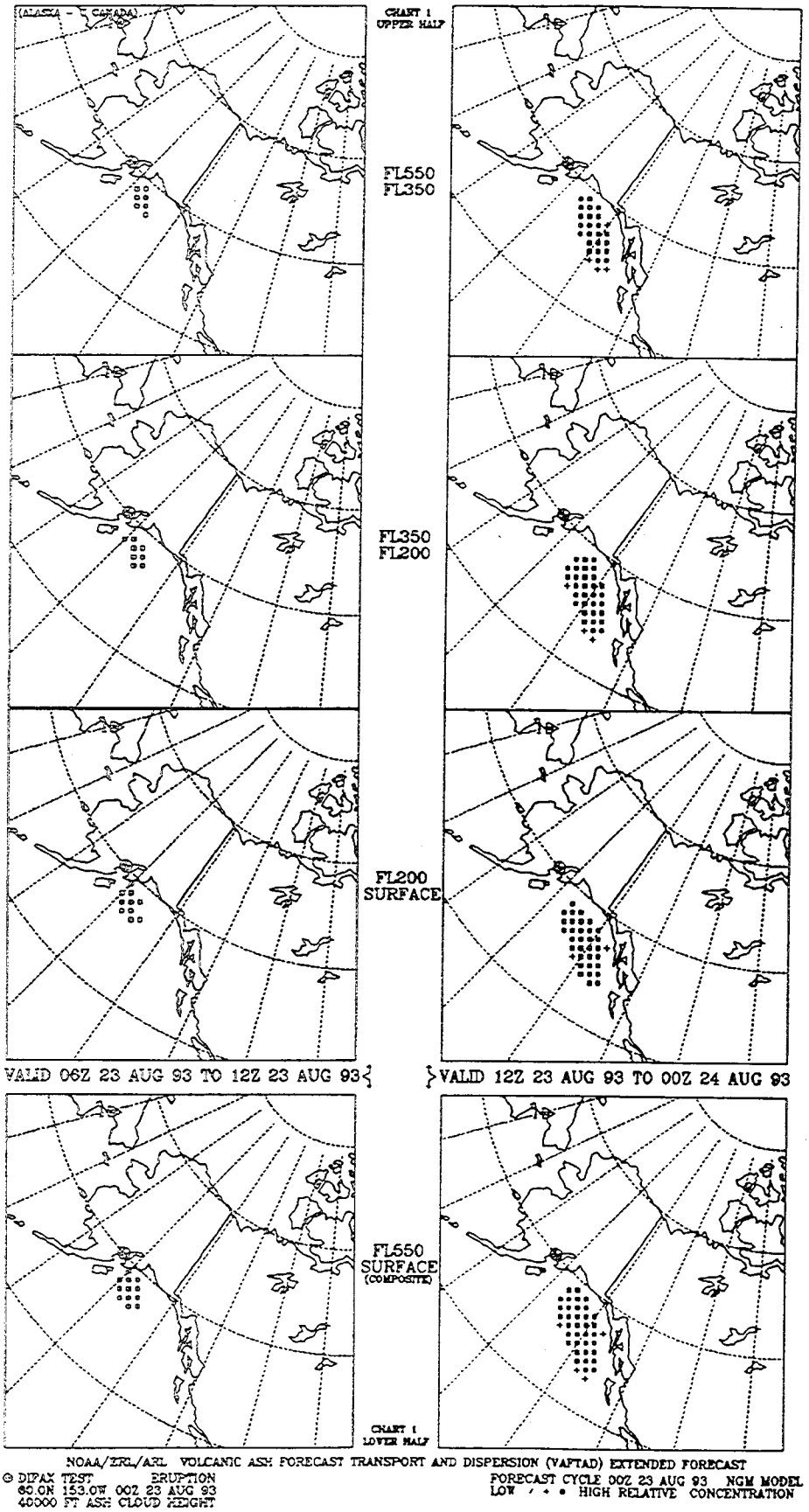


FIGURE 14-2. Volcanic Ash Forecast Transport and Dispersion Chart Six and Twelve Hour Valid Times

CHART REDUCED HERE TO 0.64 ACTUAL TRANSMISSION SIZE

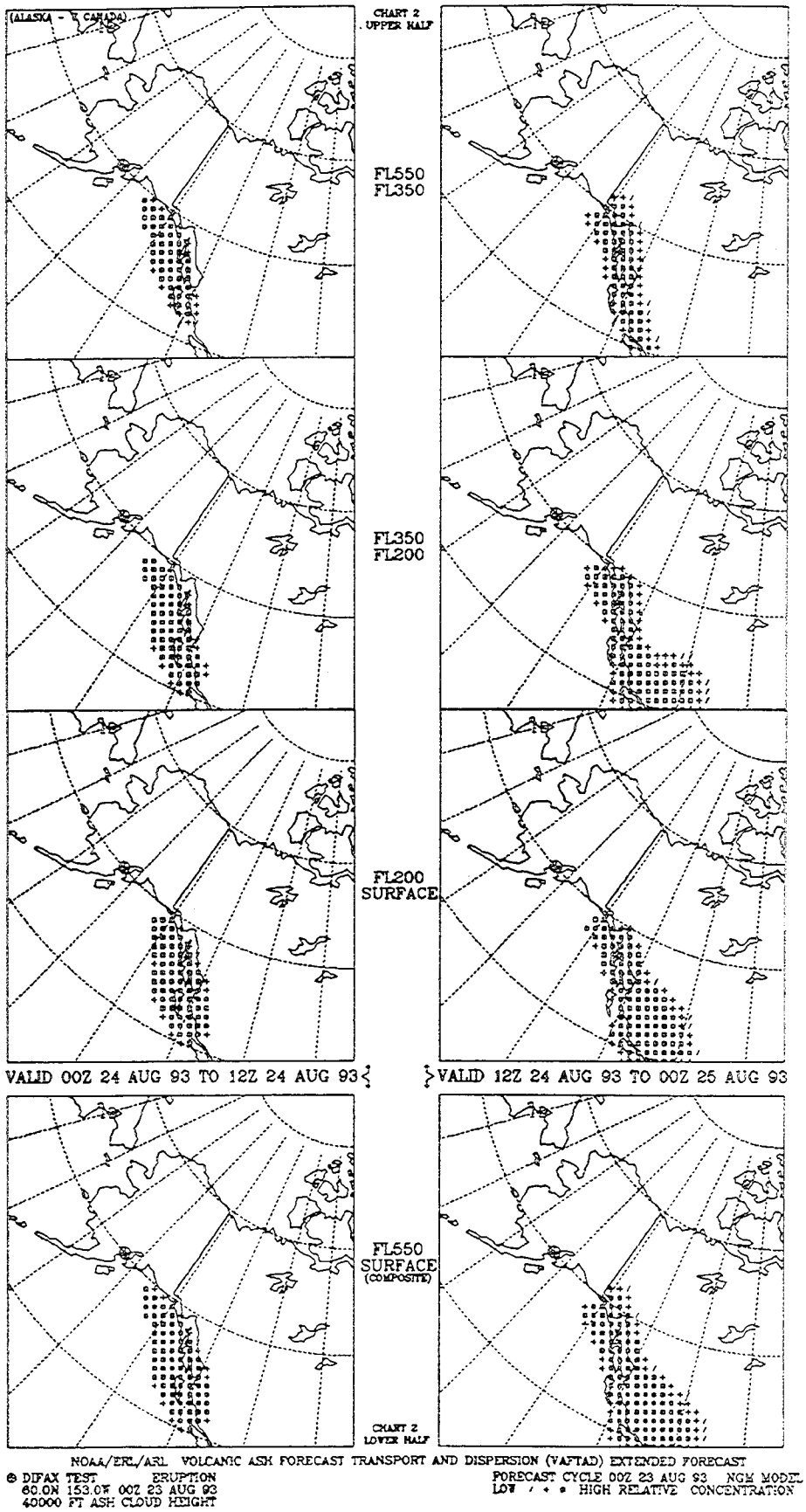


FIGURE 14-3. Volcanic Ash Forecast Transport and Dispersion Chart
Twenty-four and Thirty-six Hour Valid Times

Section 15

TABLES AND CONVERSION GRAPHS

This section provides graphs and tables that can be used operationally in decoding weather messages during preflight and inflight planning and in transmitting pilot reports. Information included covers:

1. Icing intensities and reporting.
2. Turbulence intensities and reporting.
3. Locations of probable turbulence by intensity as it relates to weather and terrain features.
4. Standard temperature, speed, and pressure conversions.
5. Density altitude computations.
6. Selected contractions.
7. Selected acronyms.
8. Scheduled issuance and valid times of forecast products.

The table of *Icing Intensities* (Table 15-1) classifies each intensity according to its operational effects on aircraft.

The table of *Turbulence Intensities* (Table 15-2) classifies each intensity according to its effects on aircraft control and structural integrity and on articles and occupants within the aircraft.

The section on *Locations of Probable Turbulence* lists each turbulence intensity along with terrain and weather features conducive to turbulence of that intensity.

The graph for *Density Altitude Computations* (see Figure 15-1) provides a means of computing density altitude, either on the ground or aloft, using the aircraft altimeter and outside air temperature.

Contractions are used extensively in surface, radar, and pilot reports and in forecasts. Most of them are known from common usage or can be deciphered phonetically. The list of *Selected Contractions* contains only those most likely to give you difficulty. Acronyms used in this manual are defined in the list of *Acronyms*.

The table of *Scheduled Issuance and Valid Times of Forecast Products* (Table 15-3) lists forecast products, and their issuance times and valid periods.

LOCATIONS OF PROBABLE TURBULENCE BY INTENSITIES AS IT RELATES TO WEATHER AND TERRAIN FEATURES

Light Turbulence

1. In hilly and mountainous areas, even with light winds.
2. In and near small cumulus clouds.
3. In clear-air convective currents over heated surfaces.
4. With weak wind shears in the vicinity of:
   a. Troughs aloft.
   b. Lows aloft.
   c. Jet streams.
   d. The tropopause.
5. In the lower 5,000 feet of the atmosphere:
   a. When winds are near 15 knots.
   b. Where the air is colder than the underlying surfaces.

Moderate Turbulence

1. In mountainous areas with a wind component of 25 to 50 knots perpendicular to and near the level of the ridge:
   a. At all levels from the surface to 5,000 feet above the tropopause with preference for altitudes:
      (1) Within 5,000 feet of the ridge level.
      (2) At the base of relatively stable layers below the base of the tropopause.
      (3) Within the tropopause layer.
   b. Extending downstream from the lee of the ridge for 150 to 300 miles.
2. In and near thunderstorms in the dissipating stage.
3. In and near other towering cumuliform clouds.
4. In the lower 5,000 feet of the troposphere.
   a. When surface winds are 30 knots or more.
   b. Where heating of the underlying surface is unusually strong.
   c. Where there is an invasion of very cold air.
5. In fronts aloft.
6. Where:
   a. Vertical wind shears exceed 6 knots per 1,000 feet, and/or
   b. Horizontal wind shear exceed 18 knots per 150 miles.

Severe Turbulence

1. In mountainous areas with a wind component exceeding 50 knots perpendicular to and near the level of the ridge:
   a. In 5,000 foot layers:
      (1) At and below the ridge level in rotor clouds or rotor action.
      (2) At the tropopause.
      (3) Sometimes at the base of other stable layers below the tropopause.
   b. Extending downstream from the lee of the ridge for 50 to 150 miles.
2. In and near growing and mature thunderstorms.
3. Occasionally in other towering cumuliform clouds.
4. 50 to 100 miles on the cold side of the center of the jet stream, in troughs aloft, and in lows aloft where:
   a. Vertical wind shear exceeds 10 knots per 1,000 feet, and
   b. Horizontal wind shear exceeds 40 knots per 150 miles.

Extreme Turbulence

1. In mountain wave situations, in and below the level of well-developed rotor clouds. Sometime it extends to the ground.
2. In severe thunderstorms (most frequently in organized squall lines) indicated by:
   a. Large hailstones (diameter 3/4 inch or greater)
   b. Strong radar echoes, or
   c. Almost continuous lightning.

DENSITY ALTITUDE COMPUTATIONS

Use the graph, Figure 15-1, to find density altitude either on the ground or aloft. Set the aircraft's altimeter at 29.92 inches, it now indicates pressure altitude. Read the outside air temperature. Enter the graph at the pressure altitude and move horizontally to the temperature. Read the density altitude from the sloping lines.

For example:

(1) Density altitude in flight. Pressure altitude is 9,500 feet and the temperature is -8 degrees C. Find 9,500 feet on the left of the graph and move to -8 degrees C. Density altitude is 9,000 feet.

(2) Density altitude for take-off. Pressure altitude is 4,950 feet and the temperature is 97 degrees F. Enter the graph at 4,950 feet and move across to 97 degrees F. Density altitude is 8,200 feet. Note that in the warm air, density altitude is considerably higher than pressure altitude.

ICING INTENSITIES

TABLE 15-1. Icing intensities, airframe ice accumulation, and pilot report

Intensity	*Airframe ice accumulation*	*Pilot report*
Trace	Ice becomes perceptible. Rate of accumulation slightly greater than rate of sublimation. It is not hazardous even though deicing/anti-icing equipment is not used unless encountered for an extended period of time (over one hour).	Aircraft indentification, location, time UTC, intensity and type of icing*, altitude/FL, aircraft type, IAS
Light	The rate of accumulation may create a problem if flight is prolonged in this environment (over one hour). Occasional use of deicing/anti-icing equipment removes/prevents accumulation. It does not present a problem if the deicing/anti-icing equipment is used.	
Moderate	The rate of accumulation is such that even short encounters become potentially hazardous and use of deicing/antiicing equipment or diversion is necessary.	
Severe	The rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate diversion is necessary.	

* Icing may be rime, clear and mixed.

Rime ice: Rough milky opaque ice formed by the instanteous freezing of small supercooled water droplets.

Clear ice: A glossy, clear or translucent ice formed by the relatively slow freezing of large supercooled water droplets.

Mixed ice: A combination of rime and clear ice.

TURBULENCE INTENSITIES

TABLE 15-2. Turbulence reporting criteria

Intensity	Aircraft reaction	Reaction inside aircraft	Reporting term definition
Light	Turbulence that momentarily causes slight, erratic changes in altitude and/or attitude (pitch, roll, yaw) Report as *Light Turbulence;** or Turbulence that causes slight, rapid and somewhat rhythmic bumpiness without appreciable changes in altitude or attitude. Report as *Light Chop.*	Occupants may feel a slight strain against belts or shoulder straps. Unsecured objects may be displaced slightly. Food service may be conducted and little or no difficulty is encountered in walking.	Occasional - less than 1/3 of the time. Intermittent - 1/3 to 2/3 of the time. Continuous - More than 2/3 of the time.
Moderate	Turbulence that is similar to Light Turbulence but of greater intensity. Changes in altitude and/or attitude occur but the aircraft remains in positive control at all times. It usually causes variations in indicated airspeed. Report as *Moderate Turbulence.** or Turbulence that is similar to Light Chop but of greater intensity. It causes rapid bumps or jolts without appreciable changes in aircraft altitude or attitude. Report as *Moderate Chop.*	Occupants feel definite strains against seat belts or shoulder straps. Unsecured objects are dislodged. Food service and walking are difficult.	NOTE 1. Pilots should report location(s), time (UTC), intensity, whether in or near clouds, altitude, type of aircraft and, when applicable, duration of turbulence. 2. Duration may be based on time between two locations or over a single location. All locations should be readily identifiable.
Severe	Turbulence that causes large, abrupt changes in altitude and/or attitude. It usually causes large variations in indicated airspeed. Aircraft may be momentarily out of control. Report as *Severe Turbulence.**	Occupants are forced violently against seat belts or shoulder straps. Unsecured objects are tossed about. Food service and walking are impossible.	
Extreme	Turbulence in which the aircraft is violently tossed about and is practically impossible to control. It may cause structural damage. Report as *Extreme Turbulence.**		

* High level turbulence (normally above 15,000 feet AGL) that is not associated with cumuliform cloudiness, including thunderstorms, should be reported as CAT (clear air turbulence) preceded by the appropriate intensity, or light or moderate chop.

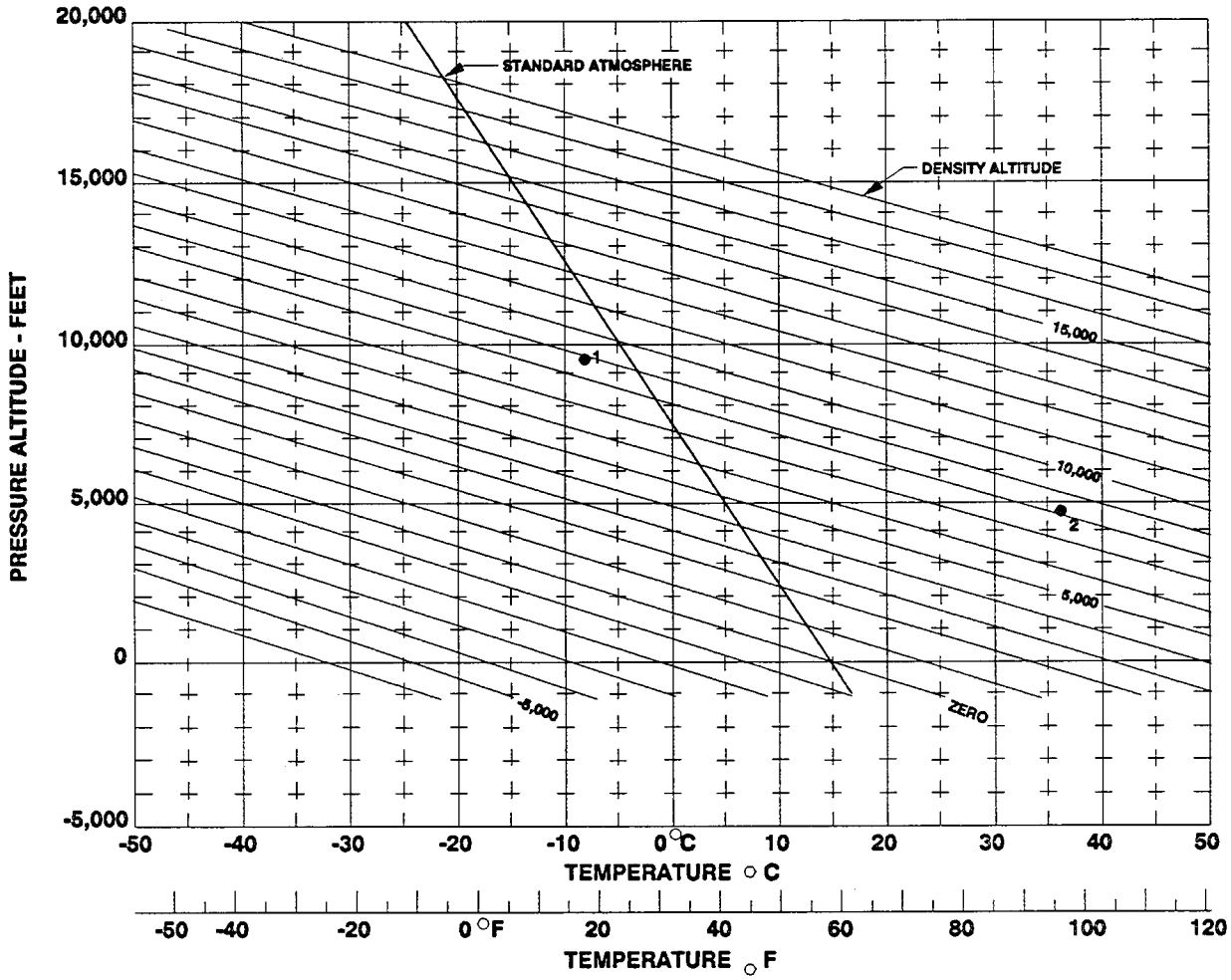


Figure 15-1. Density Altitude Computation Chart

SELECTED CONTRACTIONS AND ACRONYMS

Contractions

	A
ACLD	above clouds
ACSL	standing lenticular altocumulus
ACYC	anticyclonic
AFDK	after dark
ALQDS	all quadrants
AC	altocumulus
ACC	altocumulus castellanus
ACCAS	altocumulus castellanus
AS	altostratus
AOA	at or above
AOB	at or below
	B
BCKG	backing
BFDK	before dark
BINOVC	breaks in overcast
BL	between layers
BLZD	blizzard
BOVC	base of overcast
	C
CBMAM	cumulonimbus mamma
CC	cirrocumulus
CCSL	cirrocumulus standing lenticular
CFP	cold frontal passage
CI	cirrus
CLRS	clear and smooth
CRLCN	circulation
CS	cirrostratus
CU	cumulus
CUFRA	cumulus fractus
CYC	cyclonic

D

DFUS	diffuse
DNSLP	downslope
DP	deep
DTRT	deteriorate
DURC	during climb
DURD	during descent
DWNDFTS	downdraft

E

EMBDD	embedded

F

FNTGNS	frontogensis (front forming)
FNTLYS	frontolysis (front decaying)
FROPA	frontal passage

G

GFDEP	ground fog estimated depth (feet)

H

HDEP	haze layer estimated depth (feet)
HLSTO	hailstones
HLYR	haze layer aloft
HYR	higher

I

ICG	icing
ICGIC	icing in cloud
ICGICIP	icing in cloud in precipitation
ICGIP	icing in precipitation
INTMT	intermittent
INVRN	inversion
IPV	improve
ISOLD	isolated

K

KDEP	smoke layer estimated depth (feet)
KLYR	smoke layer
KOCTY	smoke over city

L

LLWS	low level wind shear
LTG,LTNG	lightning
LTGCC	lightning cloud to cloud
LTGCCCG	lightning cloud to cloud, cloud to ground
LTGCW	lightning cloud to water
LTGIC	lightning in cloud

M

MEGG	merging
MLTLVL	melting level
MNLD	mainland
MOGR	moderate or greater
MRGL	marginal
MSTR	moisture

N

NCWX	no change in weather
NPRS	nonpersistent
NRW	narrow
NS	nimbostratus

0

OAOI	on and off instruments
OAT	outside air temperature
OCFNT	occluded front
OCLD	occlude
OFP	occluded frontal passage
OFSHR	off shore
OI	on instruments
OMTNS	over mountains
ONSHR	on shore
OTAS	on top and smooth
OVRNG	overrunning

P

PDW	priority delayed weather
PRESFR	pressure falling rapidly
PRESRR	pressure rising rapidly
PRIND	present indications are
PRST	persist

Q

QSTNRY	quasistationary
QUAD	quadrant

R

RGD	ragged
RTD	routine delayed weather

S

SC	stratocumulus
SKC,CLR	sky clear
SNOINCR	snow depth increase in past hour
SNRS,SR	sunrise
SNST,SS	sunset
SNWFL	snowfall

SQAL	squall
SQLN	squall line
ST	stratus
STFRA	stratus fractus
STFRM	stratiform
STM	storm
	T
TCU	towering cumulus
TOVC	top of overcast
TROP	tropopause
TWRG	towering
	U
UDDF	up and down drafts
UPDFTS	updrafts
UPSLP	upslope
	V
VLNT	violent
VR	veer
	W
WDSPRD	widespread
WFP	warm frontal passage
WK	weak
WRMFNT	warm front
WSHFT	wind shift
WV	wave

Acronyms

AC	Convective Outlook Bulletin; identifies a forecast of probable convective storms.
AIRMET	Airman's Meteorological Information; an inflight advisory forecast of conditions possibly hazardous to light aircraft or inexperienced pilots.
ARTCC	Air Route Traffic Control Center.
CWSU	Center Weather Service Unit.
EFAS	En-route Flight Advisory Service (Flight Watch).
FA	Area Forecast; indentifies a forecast of general aviation weather over a relatively large area.
FD	Winds and Temperatures Aloft Forecast; a forecast identifier.
FT	Terminal Forecast; identifies a forecast in the U.S. forecast code.
GOES	Geostationary Operational Environmental Satellite.
HIWAS	Hazardous In-flight Weather Advisory Service.
ICAO	International Civil Aviation Organization.
IFSS	International Flight Service Station.
LAWRS	Limited Aviation Weather Reporting Station, usually a control tower; reports fewer elements than a complete SA.
METAR	Meteorological Aerodrome Report; international weather report in the WMO code.
NAWAU	National Aviation Weather Advisory Unit.
NESDIS	National Environmental Satellite Data and Information Service.
NEXRAD	Next Generation Radar; the new NWS Doppler Radar.
NHC	National Hurricane Center.
NMC	National Meteorological Center.
NOAA	National Oceanic and Atmospheric Administration, Department of Commerce.
NOTAM	Notice to Airmen.
NSSFC	National Severe Storms Forecast Center.
NWS	National Weather Service.
PATWAS	Pilot's Automatic Telephone Weather Answering Service; a self-briefing service.
PIREP	Pilot Weather Report.
RAREP	Radar Weather Report.
SA	Surface Aviation Weather Report; a message identifier.
SAWRS	Supplemental Aviation Weather Report; usually an airline office at a terminal not having NWS or FAA facilities.
SFSS	Satellite Field Service Station.
SIGMET	Significant Meteorological Information; an inflight advisory forecast of weather hazardous to all aircraft.
TAF	Terminal Aerodrome Forecast; identifies a terminal forecast in the WMO code.
TWEB	Transcribed Weather Broadcast; a self-briefing radio broadcast service.
UA	Pilot Weather Report (PIREP); a message identifier.
WA	AIRMET valid for a specified period, a message identifier.
WMO	World Meteorological Organization.
WS	SIGMET valid for a specified period, a message identifier.
WSFO	Weather Service Forecast Office.
WSO	Weather Service Office.
WST	Convective SIGMET; a message identifier.
WW	Severe Weather Watch; identifies a forecast of probable severe thunderstorms or tornadoes.

SCHEDULED ISSUANCE AND VALID TIMES OF FORECAST PRODUCTS

TABLE 15-3. Scheduled issuance and valid times of forecast products.

FORECAST PRODUCTS	TIME ZONE	AREA	ISSUANCE TIME	VALID PERIOD
Terminal Forecast (FT)	Eastern*		0045Z	01-01Z
	Central*		0845Z	09-09Z
			1745Z	18-18Z
	Mountain*		0145Z	02-02Z
			0945Z	10-10Z
			1845Z	19-19Z
	Pacific*		0245Z	03-03Z
			1045Z	11-11Z
			1945Z	20-20Z
		Anchorage	0345Z	04-04Z
		Fairbanks	1045Z	11-11Z
			1545Z	16-16Z
			2045Z	21-21Z
		Juneau	0345Z	04-04Z
			1045Z	11-11Z
			1445Z	16-16Z
			2045Z	21-21Z
		Honolulu	0545Z	06-06Z
			1145Z	12-12Z
			1745Z	18-18Z
			2345Z	00-00Z
		San Juan P.R.	0445Z	05-05Z
			1045Z	11-11Z
			1645Z	17-17Z
			2245Z	23-23Z
TAFs		ALL	2345Z	00-00Z
			0545Z	06-06Z
			1145Z	12-12Z
			1745Z	18-18Z
Inflight Advisories				
AIRMETs			0145Z	02-08Z
			0745Z	08-14Z
			1345Z	14-20Z
			1945Z	20-02Z
SIGMETs, and Convective SIGMETs			As needed	

* NOTE: All times are referenced to Local Standard Time (LST). For Local Daylight Time (LDT) subtract one hour.

FORECAST PRODUCTS	TIME ZONE	AREA	ISSUANCE TIME	VALID PERIOD
Area Forecast (FA)		Boston	0145Z	02-20Z
		Miami	0945Z	10-04Z
			1845Z	19-13Z
		Chicago	0245Z	03-21Z
		Dallas-	1045Z	11-05Z
		Ft. Worth	1945Z	20-14Z
		San Francisco	0345Z	04-22Z
		Salt Lake City	1145Z	12-06Z
			2045Z	21-15Z
		Anchorage	0645Z	07-13Z*
		Fairbanks	1445Z	15-21Z*
			2245Z	23-05Z*
		Juneau	0645Z	07-13Z*
			1345Z	14-20Z*
			2245Z	23-05Z*
		Honolulu	0345Z	04-22Z
			0945Z	10-04Z
			1545Z	16-10Z
			2145Z	22-16Z
			* - 30 hour forecasts	
Transcribed Weather Broadcast (TWEB)	Eastern		0140Z	02-17Z
			1940Z	10-01Z
			1840Z	19-10Z
	Central		0240Z	03-18Z
			1040Z	11-02Z
			1940Z	20-11Z
	Mountain		0340Z	04-19Z
			1140Z	12-03Z
			2040Z	21-12Z
	Pacific		0440Z	05-20Z
			1240Z	13-04Z
			2140Z	22-13Z
		Alaska	None	
		Hawaii		

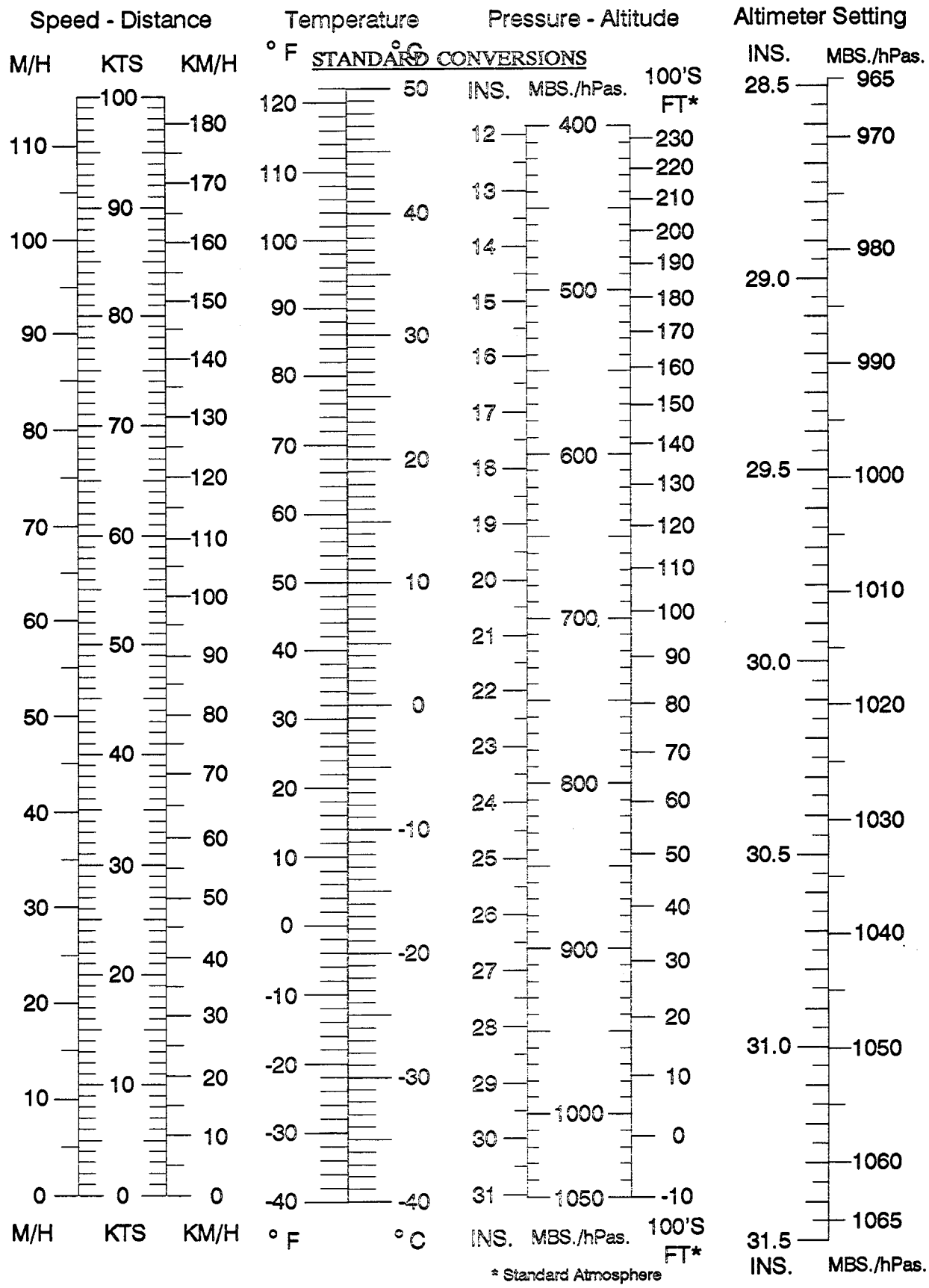


FIGURE 15-1. Standard Conversion Tables

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